WATER RESOURCES AUTHORITY
MASSACHUSETTS

Secondary Treatment Facilities Plan

SUPPLEMENT TO APPENDIX H, VOLUME III
OFF-ISLAND UTILITY SUPPLY

Draft Report
August 12, 1988

Secondary Treatment Facilities Plan

SUPPLEMENT TO APPENDIX H, VOLUME III
OFF-ISLAND UTILITY SUPPLY

Draft Report
August 12, 1988

NOTICE TO REVIEWERS

Attached for your review is the draft report "Off-Island Utility Supply", which is a supplement to Appendix H, Volume III of the Secondary Treatement Facilities Plan (STFP). A final report will be issued upon receipt and resolution of public and agency comments to this draft report. A summary of the comments and responses will be included in the final report.

This document updates and revises certain information pertaining to the interim power supply source, and utility routes which were described in Volume III of the STFP.

This document has received MWRA staff review but has not been accepted by the Board of Directors. The draft report is being circulated at this time to seek public comment; the final report will be submitted to the Board when the public review process is complete.

Charles Button, P.E.
Acting Director
Engineering Division
June, 1988

DRAFT
SUPPLEMENT TO VOLUME III
OFF-ISLAND UTILITY SUPPLY
TABLE OF CONTENTS

August 12, 1988

Appendices

Appendix A - Traffic

Appendix B - Sediment Analytical Report

Appendix C - Marine Archaeology

Appendix D - Historical and Archaeological Resources

Appendix E - Impact Modelling for Submarine Cable Installation

Draft
Supplement to Volume III
Off-Island Utility Supply
List of Tables

August 12, 1988

TABLE NUMBER		PAGE

(Continued)

Draft
Supplement To Volume III
Off-Island Utility Supply
List of Figures
August 12, 1988

FIGURE		PAGE

(Continued)

1.0 EXECUTIVE SUMMARY

1.1 VOLUME IDENTIFICATION

This document, the Off-Island Utility Supply, is a supplement to Appendix H, Energy, of Volume III to the eight-volume Secondary Treatment Facilities Plan (STFP) distributed for review on March 31, 1988. This document provides supplemental information to the Final Environmental Impact Report (FEIR) for the STFP in response to the May 18, 1988, request of the Secretary of Environmental Affairs who certified the FEIR.

1.2 INTRODUCTION

As part of the STFP, a study of utility supply alternatives was performed. In Volume III of the STFP, it was concluded that new, off-island sources of potable water, natural gas, interim electrical power, and two independent sources of permanent electrical power will be required to support the construction and operation of new wastewater treatment facilities on Deer Island.

In their February 24, 1988, Memorandum of Understanding (MOU) with the Town of Winthrop, MWRA committed to jointly providing for the long-term potable water needs of Deer Island and Winthrop, and providing appropriate connections and metering between the new gas main and existing gas distribution in Winthrop. The MOU also committed to employing a common route for the new water and gas supplies. The evaluations provided in this supplement support these objectives by recommending a route for water and gas, as well as routes for the requisite electrical power supplies.

1.3 UTILITY SOURCES

The preliminary plan for providing electrical power at Deer Island, as described in Volume III of the STFP, called for the following steps to be implemented:

- o Installation of an interim power supply from Massachusetts Electric Company's (MECo) Metcalf Square (Winthrop) substation by January 1, 1990 to meet construction power requirements;
- o Installation of the first 115 kV permanent feeder from Boston Edision Company's (BECo) K-Street Substation in South Boston by January 1, 1992;
- o Installation of a 26 MW combined cycle power plant on Deer Island by January 1, 1995;
- o Installation of a second 115 kV permanent feeder from BECo's Chelsea Substation by January 1, 1995.

Since the submittal of the final STFP, a detailed investigation by MECo has revealed that the

capacity at their Metcalf Square Substation is insufficient to meet the 15 MW interim power demand for construction of the new treatment facilities. The nearest MECo substation capable of meeting interim needs is the Revere 7 Substation, located off Railroad Avenue in Revere, about 5 miles from Deer Island. The Revere 7 Substation is only about 1.4 miles closer to Deer Island than BECo's Chelsea Substation, one of two designated sources of permanent electrical power for Deer Island.

Preliminary planning conducted by MWRA's Water Division, Boston Gas Company (Boston Gas) and the Town of Winthrop has indicated that a new 24 inch diameter water main and a new 12 inch diameter gas main would be used to convey water from MWRA's Meter 41, located at the Revere/Winthrop town line, and gas from a location adjacent to MECo's Revere 7 Substation.

1.4 DEVELOPMENT AND SCREENING OF ROUTE/SOURCE ALTERNATIVES

Two basic strategies were considered to meet the off-island utility supply needs of the new Deer Island facilities:

Strategy No. 1:

- o To limit disruption of the overland utility routes to Deer Island, concurrently install by early 1990:

    - A 20 MW interim electric power supply from MECo's Revere 7 Substation to an interim Deer Island substation to meet electrical needs until 1995;

    - A 12 inch gas main from the Boston Gas Railroad Avenue supply, adjacent to the above, and a 24 inch water main from MWRA's Meter 41.

    Water, gas and interim power would be in a common route.

- o Install by January 1, 1995:

    - A 70 MW, 115 kV permanent electric power supply from BECo's K-Street Substation to the future permanent Deer Island substation;

    - A 70 MW, 115 kV permanent electric power supply from BECo's Chelsea Substation to the future permanent Deer Island substation.

Strategy No. 2:

- o Install in early 1990:

    - A 20 MW interim electric power supply from BECo's K-Street Substation to an interim Deer Island substation. This interim supply would be designed to

ultimately provide 70 MW of permanent power to the future permanent Deer Island substation.

- o Install by January 1, 1995:

  - A 12 inch gas main from Boston Gas's Railroad Street supply, and a 24 inch water main from MWRA's Meter 41 in a common route;

  - A 70 MW, 115 kV permanent electric power supply from BECo's Chelsea Substation to the future permanent permanent Deer Island substation.

Strategy No. 1 was screened from further consideration because it was determined that it did not meet the required 1990 in-service period required to support construction power needs for Deer Island. At the earliest, implementation of interim power from MECo's Revere 7 Substation along with water and gas supplies, could not be completed before March, 1991.

1.5 DETAILED EVALUATION OF ALTERNATIVES

Eight alternative utility routes have been evaluated in detail. They provide multiple permutations for meeting the off-island utility supply requirements in Strategy No. 2.

Five alternative northern routes (i.e., N-1 and N-1A through N-1D) provide for electrical power, water and gas utility supplies in a common route to Deer Island. These routes would begin at BECo's Chelsea Substation with an electrical power supply and continue to the Boston Gas supply via Eastern Avenue in Chelsea, and Broadway and Route 16 in Revere. From the Boston Gas supply in Revere, the combined utility route proceeds to Meter 41 via Revere Beach Parkway and Winthrop Avenue. The combined utilities have five alternative routes travelling through Winthrop. Major differences in the Winthrop portions of the routes involve avoidance of a commercial area on Crest Avenue, the Dalrymple School and Veterans Road (part of the truck route to Deer Island).

One alternative northern route, N-2 provides electrical power only from BECo's Chelsea Substation via a combined overland route through East Boston and a submarine cable route which borders Logan Airport.

Two alternative southern routes (i.e., S-1 and S-2) provide electrical power from BECo's K-Street Substation in South Boston. Route S-1 proceeds from the substation to a submarine cable route via the Reserved Channel. Route S-2 is an overland route through South Boston via K-Street, Broadway and Day Boulevard to Castle Island, where it becomes a submarine cable route.

The evaluation criteria used in this analysis address technical, cost, environmental, and institutional considerations.

1.5.1 NORTHERN ROUTES

Route N-1A (refer to Figure 1.5.1-1), carrying permanent electrical power, water and gas in a common route, is recommended as the northern utility supply route to Deer Island, based on the evaluations described herein.

Comparisons of the five alternative northern routes on the basis of capital cost, technical criteria, and institutional criteria, indicate that there are no significant differences among these routes, given the conceptual-level of engineering detail in this evaluation. During the detailed engineering phase of this project's implementation, it will be possible to achieve a greater degree of resolution of the differences among the northern alternatives. At this time, however, it is expected that there are no significant differences among these routes: all five routes offer high reliability, normal constructability conditions, and relatively timely implementation; cost differences among the routes are less than seven percent; all have moderate permitting requirements; and all require extensive internal coordination for their execution.

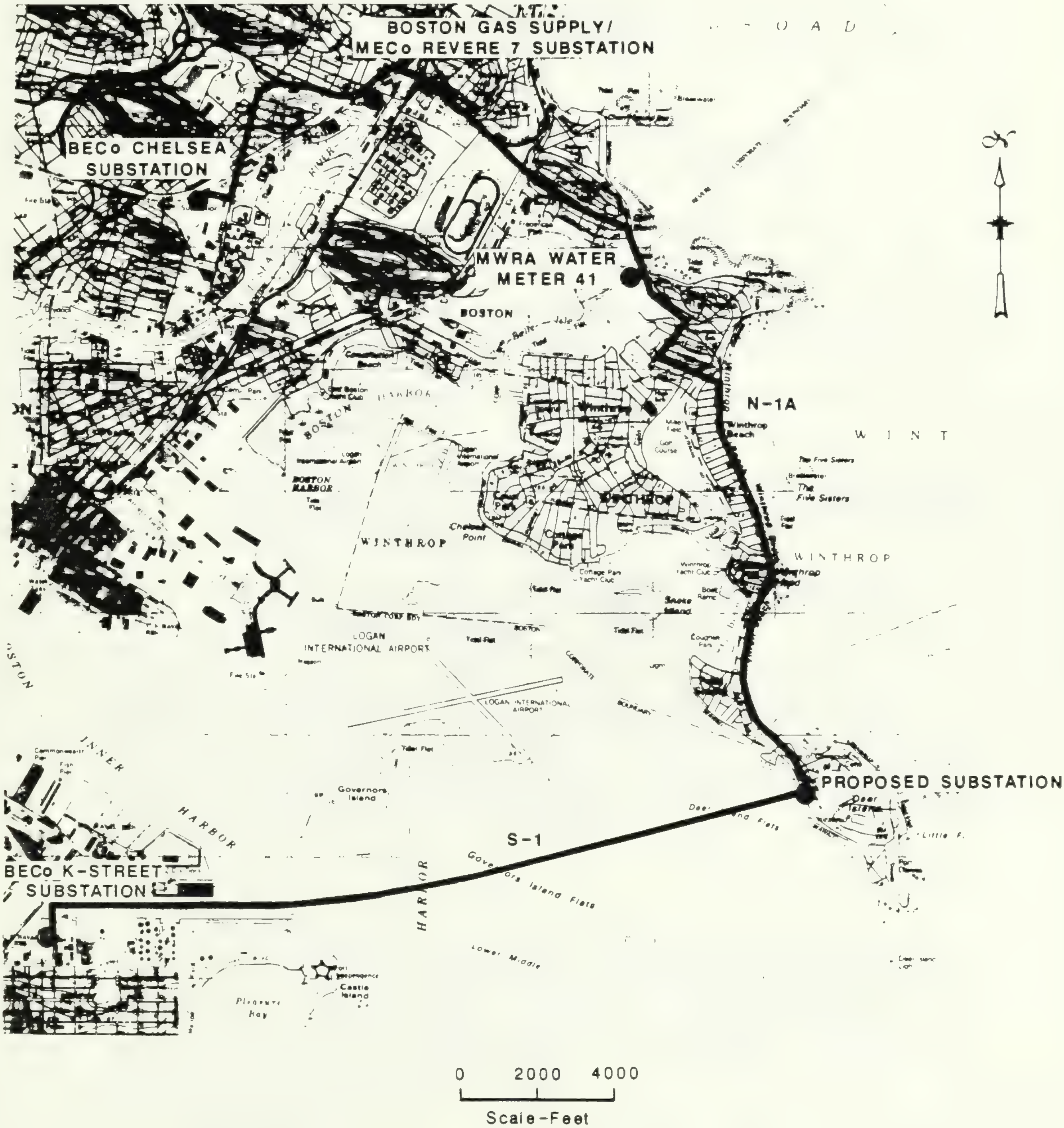
Major environmental differences between the five combined northern routes are also not readily apparent. The selection of Route N-1A is essentially based on its diminished traffic impacts relative to all other routes. Route N-1A also avoids construction in areas adjacent to schools, and minimizes the amount of construction in commercial/residential areas. While the recommended route does provide temporary impacts to beach areas in Winthrop, these impacts are temporary and can be mitigated to acceptable levels.

Route N-2, which would provide only permanent electrical power form BECo's Chelsea station, was rejected since it offers no advantages with respect to implementation schedule. With respect to all the other criteria except reliability, Route N-2 also significantly increases costs, permitting requirements, environmental impacts, etc., since it would need to be constructed in addition to a second northern, overland route carrying water and gas.

1.5.2 INTERIM AND PERMANENT POWER - SOUTHERN ROUTES

All of the northern overland utility route alternatives (N-1 through N-1D) were determined to have, at the earliest, a Spring of 1991 interim electrical power in-service date. In addition, the northern combined overland/submarine route (i.e., N-2) offers no schedule cost or environmental advantages. Therefore, alternative - southern routes were evaluated for both interim and permanent power.

Due chiefly to environmental reasons, Route S-1 (refer to Figure 1.5.1-1) is recommended as the permanent power route from BECo's K-Street Substation. Implementation of the alternative Route S-2 would entail temporary disruption to the community in South Boston, as a result of the noise and traffic impacts. The recommended route virtually eliminates land-based impacts to the community. While implementation of Route S-1 will involve temporary impacts to the marine environment resources in the Reserved Ship Channel, these impacts are minimal and are mitigated through the use of the jetting- embedment cable installation technique.



MASSACHUSETTS WATER RESOURCES AUTHORITY	FIGURE 1.5.1-1 RECOMMENDED PLAN UTILITY ROUTES

With respect to the comparative capital costs, institutional and technical criteria, Routes S-1 and S-2 are nearly identical. Both routes allow implementation of interim power in 1990.

1.6 RECOMMENDED PLAN

The recommended plan to bring off-island utilities to Deer Island to support construction and operation of the new wastewater treatment facilities consists of the following:

- o Interim electrical power rated at 20 MW from BECo's K-Street Substation in South Boston, via Route S-1; operational in 1990.
- o Permanent electrical power rated at 70 MW from the K-Street Substation using the cable and transformer installed for interim power; operational by 1995.
- o Water main from MWRA's Meter 41 located at the Winthrop/Revere town line, via Route N-1A; available in 1991.
- o Gas main from the Boston Gas Company supply on Railroad Street in Revere, via Route N-1A; installed concurrently with water main and an empty ductbank to receive electrical cables; available in 1991.
- o Permanent electrical power rated at 70 MW from BECo's Chelsea Substation, via Route N-1A; operational by January, 1995.

Implementation of interim electrical power is critical to support construction. Therefore, in the event the recommended K Street service falls behind schedule, a contingency plan is recommended. The contingency plan is to concurrently bring interim power from the Chelsea Substation. The first cable installed would serve as the interim power. The other cable would remain disconnected until needed for permanent power. The decision on the need to implement this contingency plan should be made in January, 1989.

1.6.1 ESTIMATED COST

Present day capital costs were developed for the off-island utilities. Due to the unknown subsurface conditions which will be determined during detailed design, these costs should be considered order-of-magnitude estimates. As presented below, these costs include a 35 per cent allowance for engineering and contingency. These costs exclude taxes. Under the Federal Tax Reform Act of 1986, payments to a utility reimbursing costs for facilities to be owned by the utility are no longer exempt from Federal Taxation.

Off-Island Utility	Cost
Interim and Permanent Power from K-Street	$14,500,000

Water, Gas and Empty Duct Bank	13,700,000
Permanent Power from Chelsea[1]	8,700,000
Total[2]	$36,900,000

Notes:

(1) Includes cable from Chelsea Substation to Deer Island.

(2) Does not include cost for new gas insulated substation required at Deer Island for the two sources of permanent power. This is an on-island cost and is included in STFP, Volume III.

1.6.2 SCHEDULE CONSIDERATIONS

Interim Power

Interim power is primarily required to support construction. Construction power demand will be small until the outfall and inter-island tunnel boring operations begin.

According to the present schedule, outfall tunnel boring will begin in early 1991. However, if possible, it is desirable to accelerate the start of tunnel boring into 1990. The lack of power should not be a constraint to accomplishing this. Therefore, to maintain stability in scheduling, interim power should be installed as early in 1990 as possible.

It appears that operational power shortfalls will begin to occur at the existing Deer Island primary treatment plant prior to 1990. This indicates that the on-site generating system is marginally adequate to meet the peak power demand for operations. Early installation of 20 MW interim power would also alleviate this potential shortfall.

The earliest possible in-service date for interim power is March, 1990. This is an optimistic schedule which may be obtainable if MWRA authorizes BECO to proceed by July 1, 1988; engineering field surveys begin this summer; permitting is handled expeditiously by the regulatory agencies; and no manufacturing and installation problems occur. If any of the above fails to occur, the earliest in-service date would slip to late 1990. However, installation of interim power in late 1990 is earlier than any of the alternatives considered and this date does not affect the present construction schedule.

The MWRA should take two immediate steps which are critical to meeting the early installation of interim power. First, MWRA should authorize BECo to proceed work by July, 1988. This authorization could be accomplished by signing an interim power service agreement which could initially be in the form of a letter with the interim power service agreement to follow.

Second, the MWRA should ensure that the engineering field surveys be conducted during the summer of 1988. This could be accomplished by authorizing BECo to perform the work; or MWRA could have the surveys performed. The required work includes geophysical surveys (reflection, refraction, magnometer, and side-scan sonar, soil samples), land borings and marine borings.

Water and Gas

To meet commitments to the Town of Winthrop, MWRA will bring water and gas to Deer Island as soon as possible and at the same time. The present schedule indicates that water is required at Deer Island in April, 1991 to support concrete batching operations; gas is required at Deer Island in early 1995 to fuel the proposed 26 MW on-site combined cycle power plant.

In order to avoid future disruption along the water and gas route, an empty electrical ductbank system will be installed. Thus, this manhole and ductbank system will be installed with the water and gas in 1990 and 1991. The ductbank system will be installed from the Chelsea Substation to Deer Island.

Permanent Power

With an interim power supply rated at 20 mw, both sources of permanent electrical power (K-street and Chelsea substations) are required at Deer Island in January 1995 to support treatment plant start-up and operations. To receive the two new 115 kv permanent power supplies a new gas insulated (SF-6) substation will be constructed at Deer Island by BECo. Based on recent experience, BECo recommends allowing conservatively long lead times for the SF-6 equipment.

Allowing for conservatism, an in-service date of January 1995 for both permanent power supplies is attainable. It is recommended that MWRA sign a permanent power service agreement by January 1991.

1.6.3 ENVIRONMENTAL IMPACTS

The environmental impact assessment of the recommended plan has identified the temporary effects on land and marine resources attributed directly to construction of the off-island utility supplies. No permanent environmental effects are attributed to construction or operation of the utility supplies. Overland impacts are primarily associated with temporary traffic and noise impacts; marine impacts are limited to temporary, minimal water quality effects from the submarine cable installation, and from installation of utilities along the beach in Winthrop, south of Winthrop Head.

Overland construction of the utility supplies and their associated impacts to commercial and residential areas are unavoidable, given the utility needs of the new Deer Island wastewater treatment facilities and the location of the off-island sources for these utility supplies.

The recommended utility routes which have been selected, and the recommended plans for their implementation provide for significant traffic and noise mitigation to the extent possible, given these constraining factors. In this regard, the recommended northern utility route avoids construction adjacent to schools in Winthrop; construction of the southern permanent electrical power supply route has only minimal noise impacts to commercial/residential areas. Furthermore, the use of the southern route for meeting interim electrical power needs eliminates multiple overland route construction activities which would otherwise affect Chelsea, Revere and Winthrop.

o Maximum noise impacts resulting from construction in overland portions of the utility routes comply with applicable noise codes. During overland utility route construction, noise from trenching, utility installation and backfilling will increase above ambient levels over a period of seven days as the construction activities progress along the route. A maximum level of 84 dBA will be experienced by any receptor. Noise levels will diminish to ambient levels within seven days after the construction leaves the area immediately in front of the receptor. During repaving, a maximum noise level of 86 dBA would be experienced for less than one day.

o Traffic impacts along those portions of the northern utility route which are in roadways will consist of temporary delays resulting in a reduction in average travel from 25 mph (existing) to approximately 10 mph adjacent to the construction activity. The traffic impacts associated with utility route construction will be limited to an approximate 200 feet length of in-road, open construction, at any time. In all major roadways, utility route construction will allow for two-lane, bidirectional traffic. Mitigation measures which would be implemented to ensure safe travel along the construction route include the use of flagworkers, temporary barriers, and posting. Also, along Winthrop Shore Drive, adjacent to Winthrop Beach, construction will not be performed between Memorial Day and Labor Day.

o Approximately one mile of the northern route would be constructed adjacent to the seawall on Yirrell Beach, south of Winthrop Head and continuing to Deer Island. This construction will take place above the mean high water mark and would not be performed during the peak beach recreational period between Memorial Day and Labor Day. Mitigation measures will be implemented to minimize the temporary disruption to the beach; the beach will be returned to its preconstruction conditions upon completion of construction.

o Impacts to marine resources associated with submarine cable installation are primarily limited to a minimal, temporary increase in turbidity in the immediate area of the jetting-embedment operation.

o Impacts to on-land historic/archeological resources along the construction route are the same as for commercial/residential properties: potential for temporary access limitation, increased noise; and dust. No permanent effects to these resources are expected. Documentary research has indicated that the potential for impacting historic shipwrecks along the submarine cable route is minimal.

- Construction of the utility routes will have no effects on the current or future potential for recreational opportunities. Temporary noise impacts will be experienced at three parks/recreational areas where construction of the overland portion of the route is adjacent to these areas.

2.0 BASIC PLANNING CRITERIA

2.1 BACKGROUND

To support operations of the proposed secondary wastewater treatment plant at Deer Island, it will be necessary to bring new utilities to Deer Island from offsite sources. The new utilities consist of two sources of purchased permanent electrical power (100 percent redundancy), natural gas, and potable water. Also, to support construction of the new treatment plant it will be necessary to provide an interim source of electrical power. This interim construction power could be provided by either a separate third source or by one of the two permanent electrical power sources.

As part of the STFP, a study of energy supply alternatives was performed. This study is included in Appendix H of Volume III. The recommended plan is described in Volume III, page 11-66, Plant Utilities, and is summarized below.

2.1.1 ELECTRICAL POWER

Currently, no public electric utility service exists at the Deer Island wastewater treatment facility. All electrical energy currently consumed at the facility is self-generated onsite by five 700 kw diesel engine-driven generators. In addition, all but one of the existing influent pumps at the Main Pumping Station are diesel engine-driven. As part of the ongoing Fast Track Improvement Program, four additional influent pumps are being electrified. To support this conversion, two additional 6,000 kw diesel engine-driven generators are being installed and should be in operation by early 1989.

The electric power required for the period of 1986 to 1999 and beyond for the combined construction activities and wastewater treatment operations on Deer Island associated with Fast-Track Improvements, Pier Facilities, Interim Sludge Disposal, full Primary and Secondary Treatment, and Residuals Management, is summarized in Table 2.1.1-1. Based on these needs, alternative methods of satisfying the energy requirements through a combination of onsite generation and offsite supply were evaluated, and a plan of action was recommended. Implementation of the recommended plan for providing sufficient reliable power to Deer Island consisted of the following steps:

1. Complete installation of an interim power supply by January 1, 1990 to meet construction power requirements;

2. Complete installation of the first 115 kv permanent feeder from Boston Edison Company's (BECo) K Street substation, South Boston, by January 1, 1992;

3. Complete installation of an on-site combined cycle power plant by January 1, 1995;

4. Complete installation of the second 115 kv permanent feeder from BECo's Chelsea substation by January 1, 1995.

TABLE 2.1.1-1

PRELIMINARY POWER NEEDS OF
SECONDARY TREATMENT FACILITIES PLAN

Year	Description of power needs	Average load (kw)	Cumuative average load (kw)	Peak load (kw)	Cumulative peak load (kw)	Cumulative installed capacity (kw)	Cumulative secure capacity (kw)	Cumulative shortfall (kw)
1986	One electrified influent pump	1,500		1,500		3,500	2,800	
	Basic power usage	650		650				
			2,150		2,150	3,500	2,800	0
1988	Electrification of four additional influent pumps and Winthrop terminal pumps	2,500		7,200		12,000	6,000	
			4,650		9,350	15,500	8,800	550
1990	Construction power	10,000		15,000		0	0	
			14,650		24,350	15,500	8,800	15,550
1992	Piers, primary sludge dewatering, and basic power	4,000		4,500		0	0	
			18,650		28,850	15,500	8,800	20,050
1995	Primary treatment and basic power usage	7,800		9,400				
1995	Electrification of five influent pumps,							

TABLE 2.1.1-1

PRELIMINARY POWER NEEDS OF
SECONDARY TREATMENT FACILITIES PLAN
(Continued)

Year	Description of power needs	Average load(kw) period	Cumuative average load (kw)	Peak load (kw) period	Cumulative peak load (kw)	Cumulative installed capacity (kw)	Cumulative secure capacity (kw)	Cumulative *shortfall (kw)
	Winthrop terminal pumps and South System flows:	4,100		17,700				
	Air emissions control:	500		1,250				
	Construction Power/ Enterprise engines retired	-7,000	24,050	-12,000	45,200	-3,500 12,000	-2,800 6,000	39,200
1999	Secondary facilities and basic power usage	13,500		19,400				
	Additional air emissions control:	250		625				
	Sludge process:	2,000		2,000				
	Construction power	-3,000	36,800	-3,000	64,225	12,000	6,000	58,225

* Secure capacity is that capacity which, because it is provided from two separate sources, is considered to be totally reliable in accordance with EPA technical criteria as specified in EPA Technical Bulletin EPA - 430-99-74-001.

Interim Power

Based on Table 2.1.1-1, an electrical power shortfall of approximately 15 mw will exist in 1990. This shortfall is expected to increase to 20 mw in 1992, 39 mw in 1995 and 58 mw in 1999.

In 1987, during preparation of the STFP, preliminary discussions were held with Boston Edison Company (BECo). BECo identified the two independent sources of permanent electrical power as its K-Street substation in South Boston and its Chelsea substation located off Eastern Avenue in Chelsea. The K-Street substation is located approximately four miles across Boston Harbor from Deer Island; the Chelsea substation is located approximately six miles from Deer Island.

Based on a preliminary assessment it did not appear likely that a permanent electrical cable could be installed by January, 1990 to also meet the 15 mw construction demand. However, a permanent power cable could be installed by January, 1992 to meet the 20 mw demand. To supply power by January, 1990 it appeared that a source closer to Deer Island would have to be tapped. Preliminary information indicated that Massachusetts Electric Company (MECo) could possibly meet the 15 mw demand in 1990 by supplying power from its Metcalf Square substation in Winthrop, approximately 2.5 miles from Deer Island. Since Deer Island is within BECo's licensed service territory, the preliminary plan was for BECo to purchase this interim supply of power from MECo and sell it to the Massachusetts Water Resources Authority (MWRA).

In February, 1988, MWRA executed a service agreement with BECo, requesting 15 mw of interim power. This allowed MECo to begin a detailed investigation. As a result, MECo determined that sufficient capacity was unavailable at its Metcalf Square substation. MECo's closest substation capable of supplying 15 mw is its Revere 7 substation, located off Railroad Avenue in Revere, approximately five miles from Deer Island. MECo has also determined that up to 20 mw of power is available from its Revere 7 substation. Given this location, the source of interim power is nearly the same distance from Deer Island as the proposed permanent power sources. Therefore, the need and advantages of installing a third power source must be reconsidered. If interim power is to be provided by MECo, this service should be sized for the available 20 mw, which is sufficient to meet electrical demand at Deer Island until 1995.

Permanent Power from K-Street Substation

Based on a preliminary review of its transmission system and the estimated loads, BECo has presently designated the K-Street substation as the primary permanent feeder. The primary feeder will normally supply all offsite electrical power to Deer Island. The second permanent feeder will be used as a back-up. Therefore, as a permanent power supply, it is recommended that the K-Street feeder be installed first.

As shown in Table 2.1.1-1, the peak electrical load is estimated to be 64 mw in 1999. For equipment and cable sizing purposes, no credit should be taken for on-site generation. Allowing for the preliminary nature of the estimated peak load, the 115 kv permanent feeder from the K-Street substation should be sized for 70 mw.

Based on Table 2.1.1-1, an electrical power shortfall of approximately 20 mw will exist in 1992. During preparation of the STFP in 1987, it appeared that a maximum of 15 mw for interim power could possibly be supplied from MECo's Metcalf Square substation. Therefore, in order to meet the 20 mw shortfall, completion of the first 115 kv permanent feeder from BECo's K-Street substation was scheduled for January, 1992.

As discussed above (under Interim Power), if an interim source of electrical power is provided by MECo, this service would be sized for 20 mw to meet the demand at Deer Island until 1995. Then, completing the first 115 kv permanent feeder by January, 1992 is not critical. However, if it is determined than an interim power source from MECo is not needed, cannot be installed on time, or represents no cost benefit, then the K-Street feeder should be installed in early 1990 to provide interim construction power.

Permanent Power from Chelsea Substation

In accordance with EPA reliability requirements, permanent power must be provided from two separate and independent sources. To satisfy this criterion, either a second 115 kv permanent feeder from BECo's Chelsea substation or additional on-site capacity to meet total power needs must be installed by January, 1995. For the purposes of this study it is assumed that a second BECo feeder will be installed. In order to provide 100 percent backup capability, the second BECo feeder from the Chelsea substation should also be sized for 70 mw.

MWRA should re-evaluate the economics and environmental impacts of these alternatives prior to authorizing design of the on-site combined cycle power plant currently sized at 26 MW, and the second 115 kV permanent feeder from BECo.

2.1.2 NATURAL GAS

Part of the STFP recommended plan for power generation included installation of a 26 MW on-island combined cycle power plant by January, 1995. Since preparation of the STFP in 1987, Boston Gas has indicated that it can provide sufficient gas to fuel the combined cycle power plant. The existing supply source is located off Railroad Avenue in Revere. This location is adjacent to MECo's Revere 7 electrical substation.

A new gas pipeline, approximately 12 inches in diameter will be installed from the existing supply source, identified above, to Deer Island. This pipeline is sized for the 26 MW power plant. If, as a result of future re-evaluation, the MWRA recommends installing a larger on-site power plant, the gas pipeline size would also increase. For example, for a 58 MW on-site power plant, the largest unit considered by the MWRA (STFP, Volume III, Appendix H), Boston Gas Company has indicated a preliminary line size of 18 inches in diameter would be required.

2.1.3 POTABLE WATER

To satisfy potable water requirements for the new secondary wastewater treatment plant, a new

water main will be installed. The water supply source is the MWRA's Northern High Distribution System, via a connection at Meter 41 located at the Winthrop/Revere boundary. The new water main, approximately 24 inches in diameter, will be installed from Meter 41 to Deer Island.

2.2 UTILITY SUPPLY STRATEGY

2.2.1 DESCRIPTION OF STRATEGIES

To meet the requirements for new electric, water, and gas utilities, two basic strategies were considered. These strategies are described below and summarized in Table 2.2.1-1.

Strategy No. 1

Interim Power, Gas, and Water

- Install a 20 MW interim electric power supply from MECo's Revere 7 Substation.

- Since the new gas main originates at the same location as the interim power (Railroad Avenue, Revere), and because it is desirable to disrupt any overland route to Deer Island only once for construction, install the 12 inch diameter gas main concurrent with the interim power.

- The location of Meter 41 at the Winthrop/Revere line is along the way of the interim power and gas main route. Again, in order to disrupt any overland route to Deer Island only one time during construction, install the 24 inch diameter water main concurrently with the interim power and gas main.

Permanent Power from K-Street Substation

- Install a 70 MW, 115 kV, permanent electric power supply from BECo's K-Street Substation by January, 1995.

Permanent Power from Chelsea Substation

- Install a 70 MW, 115 kV backup permanent electric power supply from BECo's Chelsea Substation by January, 1995.

Strategy No. 2

Interim/Permanent Power from K-Street Substation

- Install a 20 MW interim electric power supply from BECo's K-Street Substation in

TABLE 2.2.1-1

OFFSITE UTILITIES SUPPLY STRATEGIES

UTILITY		
INTERIM POWER	**STRATEGY NO. 1**	**STRATEGY NO. 2**
Supplier	MECo	BECo
Location	Railroad Avenue	K-Street, South Boston
In-Service	Early 1990	Early 1990
Capacity, MW	20	20
Voltage, kV	24	(later)/115 [1.]
Natural Gas		
Supplier	Boston Gas Co.	Boston Gas Co.
Location	Railroad Avenue	Railroad Avenue, Revere
In-Service	Early 1990 [2.]	Prior to 1/95 [3.]
Line Size, inches	12	12
Water		
Supplier	MWRA	MWRA
Location	Winthrop/Revere town line	Winthrop/Revere town line
In-Service	Early 1990 [2.]	Prior to 1/95 [3.]
Line Size, inches	24	24
Permanent Power No. 1		
Supplier	BECo	BECo
Location	K-Street, South Boston	K-Street, South Boston
In-Service	1/95	1/95
Capacity, MW	70	70
Voltage, kV	115	(later)/115 [1.]
Permanent Power No. 2		
Supplier	BECo	BECo
Location	Eastern Avenue, Chelsea	Eastern Avenue, Chelsea
In-Service	1/95	1/95
Capacity, MW	70	70
Voltage, kV	115	115

Notes

1. For Strategy No. 2, BECo will install a cable from its K-Street Substation rated at 115 kV and sized for 70 MW. Between 1990 and 1995, the peak demand is estimated at 20 MW. During this period BECo may operate this cable at a lower voltage.

2. With Strategy No. 1, the new gas and water utilities would be installed concurrently with interim power, which dictates the schedule.

3. With Strategy No. 2, the new gas and water utilities would be installed at the earliest possible date consistent with a negotiated agreement with Winthrop. These utilities are required at Deer Island, for plant operations, prior to January, 1995.

early 1990. This substation is also the primary source of permanent power. Therefore, to the extent possible the interim power supply would be constructed to also serve as the permanent source of power. The cable will be rated for 115 kV. It will be sized to provide 20 MW of interim power at 115 kV (or lower), and 70 MW of permanent power.

Gas and Water

- Install a new 12 inch diameter gas main from Railroad Avenue in Revere to Deer Island. Pick up the new 24 inch diameter water line at Meter 41 on the Winthrop/Revere line and install both utilities to Deer Island at the same time. The gas supply would not be required at Deer Island until January, 1995; potable water demand will likely increase beyond existing Deer Island supply capacity in 1991-1992, reaching near peak demand in January, 1995. However, both services would be installed at the earliest possible date consistent with a negotiated agreement with Winthrop.

Permanent Power from Chelsea Substation

- Install a 70 MW, 115 kV back-up permanent electric power supply from BECO's Chelsea Substation by January, 1995.

2.2.2 SCHEDULE CONSIDERATIONS

Based on schedule considerations, Strategy No. 2 is selected as the basis for detailed evaluation, as described below.

Strategy No. 1

Under Strategy No. 1, the MWRA would install the interim power cable for MECo concurrently with the new natural gas main for Boston Gas Co. and the new water line. One construction contract for all three utilities would be let by the MWRA. Under existing MWRA contracting procedures for this project, nine months is normally required for funding agency (DEQE) approval, bidding, bid evaluation, MWRA Board of Directors approval, and contract award.

It is assumed that the most direct route to Deer Island would be approved (see Section 2.4, Route N-1). The schedule would not increase for any of the alternative routes considered. A schedule for Strategy No.1 was developed. As shown on Figure 2.2.2-1, the earliest estimated interim power in-service date would be June, 1991. This would not support construction. Thus, Strategy No. 1 is screened from further consideration because it does not meet the required in-service date required to support construction. In addition, there are other disadvantages associated with it:

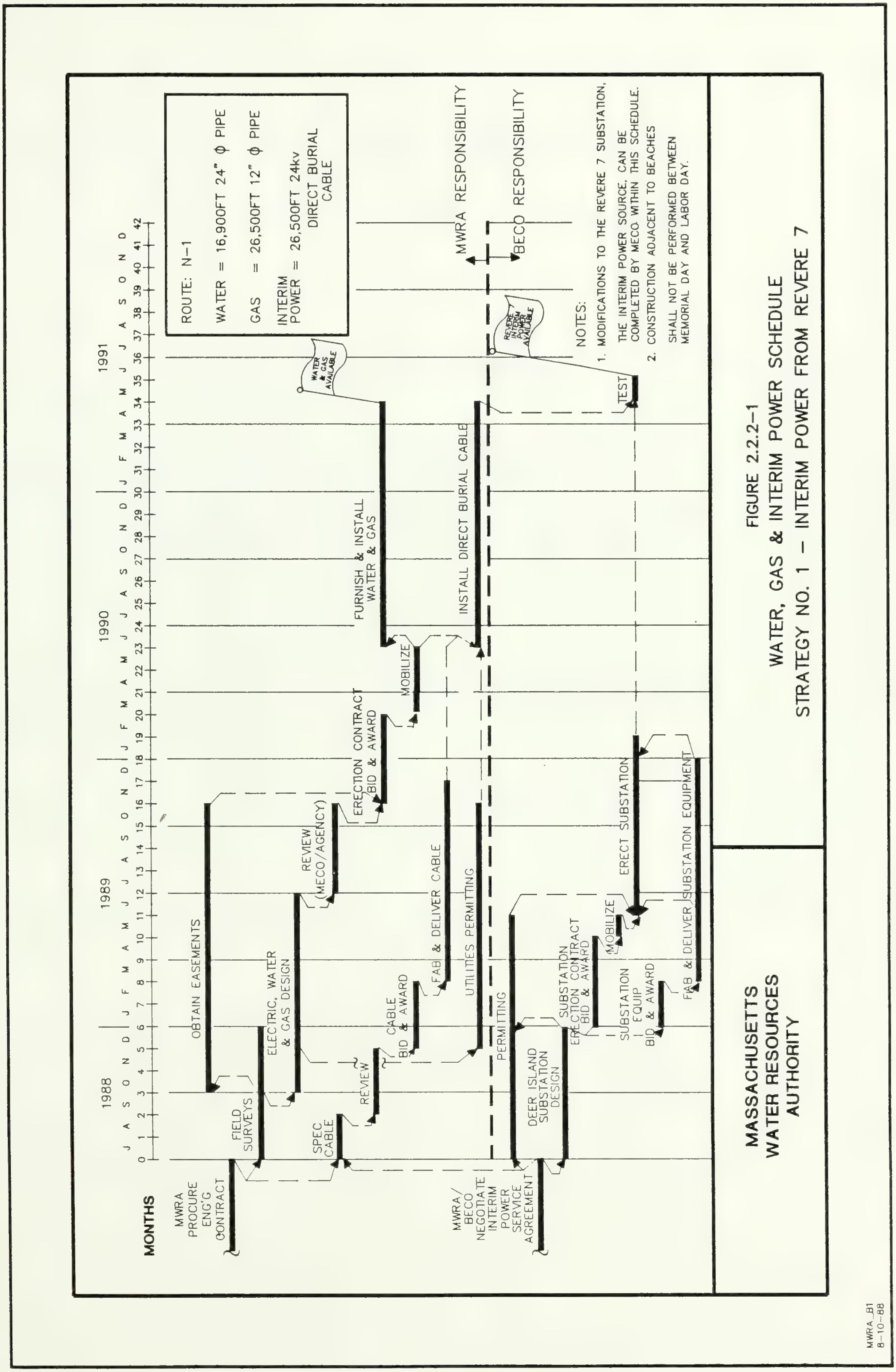


FIGURE 2.2.2-1
WATER, GAS & INTERIM POWER SCHEDULE
STRATEGY NO. 1 – INTERIM POWER FROM REVERE 7

1. Of all the off-site utilities, it is critical to install only interim power by early 1990. By combining construction of all three utilities, the installation becomes more complex. This increases the risk of not meeting schedule.

2. Any problem associated with procurement, installation and inspection of any one utility will delay interim power.

Strategy No. 2

Under Strategy No. 2, BECo would install the interim power as one project. MWRA would install the water and gas as another independent project.

A schedule was developed for Strategy No. 2. As shown on Figure 2.2.2-2, the earliest estimated in-service date for interim power is March, 1990. Following its contracting procedures, MWRA could have water and gas installed by May, 1991. This schedule meets the construction and operational needs of the new wastewater treatment plant and it is consistent with the MWRA/Winthrop agreement to install new gas and water utilities as soon as possible.

Strategy No. 2 is selected as the basis for detailed evaluation.

2.3 SUMMARY - UTILITY SUPPLY STRATEGY

To support construction and operation of the new secondary wastewater treatment plant, new utilities originating off-site must be brought to Deer Island in addition to the construction of a new 26 MW combined cycle plant on site.

To support construction, 20 MW of power should be installed by early 1990. This power should be provided at 115 kV (or lower) by having BECo install the first 115 kV permanent power feeder from its K-Street Substation in South Boston by early 1990.

To support plant operations, two independent sources of permanent electric power, each rated at 70 MW, should be installed prior to January 1995. This power can be provided at 115 kV by BECo from its K-Street Substation in South Boston and from its Chelsea Substation off Eastern Avenue in Chelsea.

Also, to support operations, a new 24 inch diameter water line and a new 12 inch diameter gas main will be installed to Deer Island. The water line will originate at MWRA's Meter 41 located at the Winthrop/Revere town line. The gas main will originate at Boston Gas Company's existing supply off Railroad Avenue in Revere, adjacent to MECo's Revere 7 Substation.

The timely implementation of this strategy is crucial to the support of construction. Therefore, the schedule should be closely monitored. If implementation of the K-Street feeder

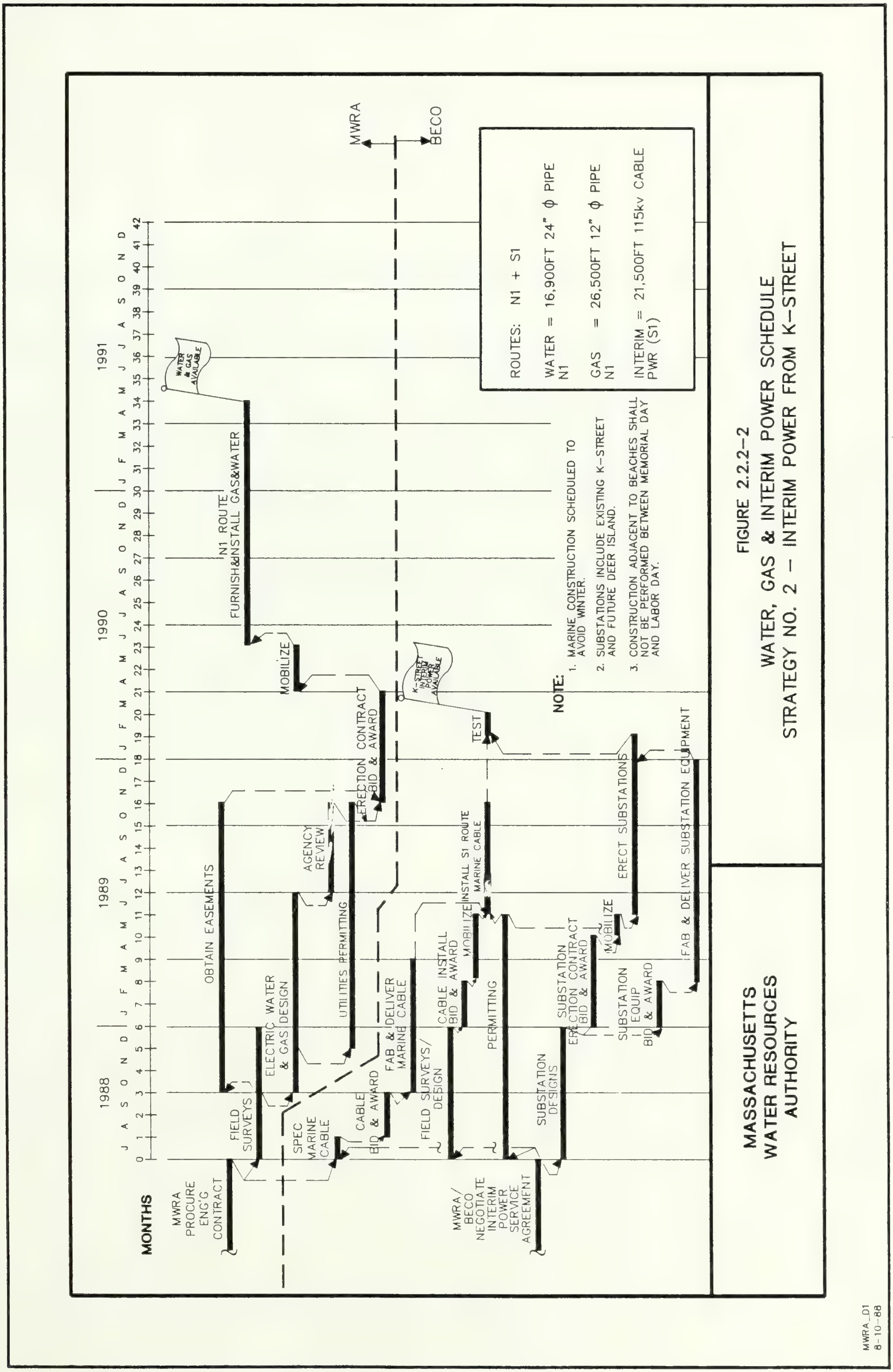


FIGURE 2.2.2-2
WATER, GAS & INTERIM POWER SCHEDULE
STRATEGY NO. 2 – INTERIM POWER FROM K-STREET

falls behind schedule a contingency plan should also be implemented. The contingency plan consists of accelerating the Chelsea feeder and is described in more detail in Section 4.1.4.

2.4 DESCRIPTION OF ALTERNATIVE ROUTES

2.4.1 INTRODUCTION

As described in Section 2.3, it will be necessary to bring a water line, a gas main, an interim source of power and two sources of permanent power to Deer Island.

A 24 inch potable water main, a 12 inch gas main, and a 115 kv permanent power line will come from the north. An interim power/permanent power line will come from the south.

The Boston Gas source is located on Railroad Avenue off Route 16 in Revere. The potable water connection will be at MWRA Meter 41 off Winthrop Avenue on the Winthrop/Revere Town Line. The permanent power source for the northern route will be the BECo Chelsea Substation located off Eastern Avenue in Chelsea. The interim power source and the permanent power source for the southern route will be the BECo K-Street Substation in South Boston.

A total of eight alternative routes have been considered; six from the north and two from the south. From the north, five of the alternative routes (N-1, N-1A, N-1B, N-1C, N-1D) could carry water, gas, and electric power.

The other alternative route from the north, N-2, could only carry electric power. Therefore, for any alternative considering Route N-2, it will be necessary to couple it with one of the five alternative routes from the north, Route N-1, N-1A, N-6B, N-1C or N-1D, to carry the water and gas to Deer Island.

2.4.2 POTABLE WATER, NATURAL GAS AND PERMANENT POWER

Northern Routes

The permanent power source for the northern route is Boston Edison Company's Chelsea Substation located off Eastern Avenue in Chelsea. Route N-1 (refer to Figure 2.4.2-1) originates at the Chelsea Substation and travels east to Eastern Avenue, heads north on Eastern Avenue to Broadway, northeast on Broadway to Route 16 and east on Route 16 to Railroad Street where the gas main will begin. The route runs along the railroad tracks to Revere Beach Parkway (Route 16). It then follows Route 16 to Winthrop Avenue where it heads in a southeasterly direction across the Winthrop town line. The potable water main begins here at Meter 41. The three utilities then follow Revere Street, Crest Avenue and Winthrop Shore Drive. At the southern end of Winthrop Shore Drive, the route leaves the road and follows the landward side of the seawall around Winthrop Head and then runs under the seawall and parallels Yirrell Beach on the seaward side of the seawall, and continues along the beach to Deer Island.

MASSACHUSETTS WATER RESOURCES AUTHORITY

FIGURE 2.4.2-1
ALTERNATE ROUTE N-1

Route N-1 is the base northern route for the alternative which carries water, gas, and electricity. There are four additional variations of this route which provide options for reaching Deer Island. These four routes are the same as Route N-1 up to the intersection of Crest Avenue and Revere Street in Winthrop; it is from this point on that they vary.

Route N-1A (refer to Figure 2.4.2-2) avoids Crest Avenue by continuing south on Revere Street and heading east on Locust Street to connect with Winthrop Shore Drive. From this point on it is the same as Route N-1.

Route N-1B (refer to Figure 2.4.2-3) follows the Deer Island Truck route which continues south on Revere Street, east on Shirley street, south on Veterans Road, briefly east on Washington Street to Shirley Street, south on Shirley Street, and south on Tafts Avenue to Deer Island.

Route N-1C (refer to Figure 2.4.2-4) is the same as Route N-1 until it reaches Tewksbury Street located just north of Cottage Hill. Tewksbury Street connects Shirley Street with Winthrop Shore Drive. This section is used to cut over to Shirley Street from Winthrop Shore Drive to avoid the southern portion of Route N-1 which runs along the beach. The route then follows the same route as N-1B to Deer Island.

Route N-1D (refer to Figure 2.4.2-5) is the same as Route N-1A up to Adams Street which is located south of Yirrell Beach. This route travels down Adams Street to Tafts Avenue and follows Tafts Avenue to Deer Island.

2.4.3 PERMANENT POWER

Northern Route

As an alternative, permanent power would be separated from water and gas and it could be brought in along Route N-2 (refer to Figure 2.4.3-1).

Route N-2 originates at the Chelsea Substation and runs east to Eastern Avenue, it then heads south on Eastern Avenue to Marginal Street, along Marginal Street to a point where it heads south and crosses the Chelsea River in an existing conduit. The route then travels cross-country to Condor Street and connects to Shelby Street in East Boston: it continues across Saratoga Street, to Neptune Street, then northeast on Bennington Street, to Trident Road. It then follows Trident Road in a southeasterly direction and crosses Orient Heights Beach. Via a submarine route, it continues southeast across Boston Harbor, southwest around Logan Airport, and southeast around Chelsea Point to Deer Island.

When evaluating Route N-2, which carries only electric power, it is necessary to combine it with one of the five alternative N-1 routes carrying water and gas.

Another route, similar to N-2, crosses Logan Airport. It was rejected due to the restraints involved with constructing within the boundaries of Logan Airport.

MASSACHUSETTS WATER RESOURCES AUTHORITY

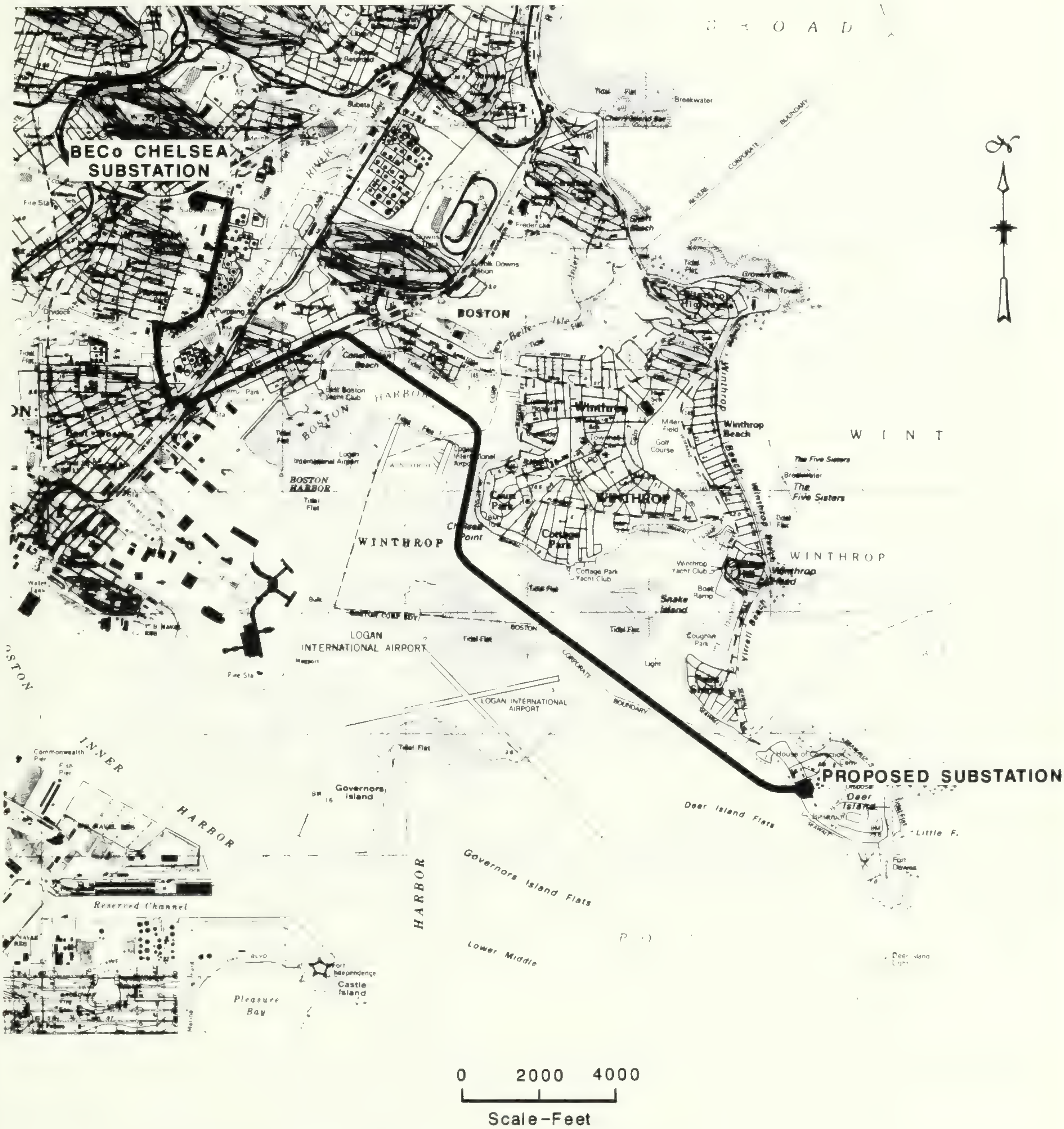
FIGURE 2.4.2-2
ALTERNATE ROUTE N-1A

MASSACHUSETTS WATER RESOURCES AUTHORITY	FIGURE 2.4.2-3 ALTERNATE ROUTE N-1B

MASSACHUSETTS WATER RESOURCES AUTHORITY	FIGURE 2.4.2-4 ALTERNATE ROUTE N-1C

MASSACHUSETTS WATER RESOURCES AUTHORITY

FIGURE 2.4.2-5
ALTERNATE ROUTE N-1D



MASSACHUSETTS WATER RESOURCES AUTHORITY	FIGURE 2.4.3-1 ALTERNATE ROUTE N-2

2.4.4 INTERIM AND PERMANENT POWER

Southern Routes

The interim power source and the permanent power source for the southern route is the Boston Edison Company K-Street Substation in South Boston. There are two southern alternative routes: an underwater route (S-1); and a combined overland and underwater route (S-2). Route S-1 (refer to Figure 2.4.4-1) heads north from the K-Street Substation and then east through the Reserved Ship Channel and northeasterly across Boston Harbor to Deer Island.

Route S-2 (refer to Figure 2.4.4-2) runs south from the K-Street Substation along K Street to Broadway where it heads east on Broadway to Wm. J. Day Boulevard, along Wm. J. Day Boulevard to Castle Island, and then northeasterly across Boston Harbor to Deer Island.

A third route which runs along First Avenue instead of Broadway was rejected due to the number of utilities which already are located within in the street.

2.5 CONSTRUCTION REQUIREMENTS

New water, gas and electric utilities will be brought from the north to Deer Island. All three utilities will be installed along overland routes. Electric power, by itself, will also be installed from the south along underwater routes.

Along the overland routes, various combinations of utilities from electric only to water, gas, and electric may be installed. Construction requirements for the overland routes will generally conform to standard utility construction practice. These requirements are discussed in Section 2.5.1. The MWRA will also implement the requirements of its Memorandum of Understanding with the Town of Winthrop.

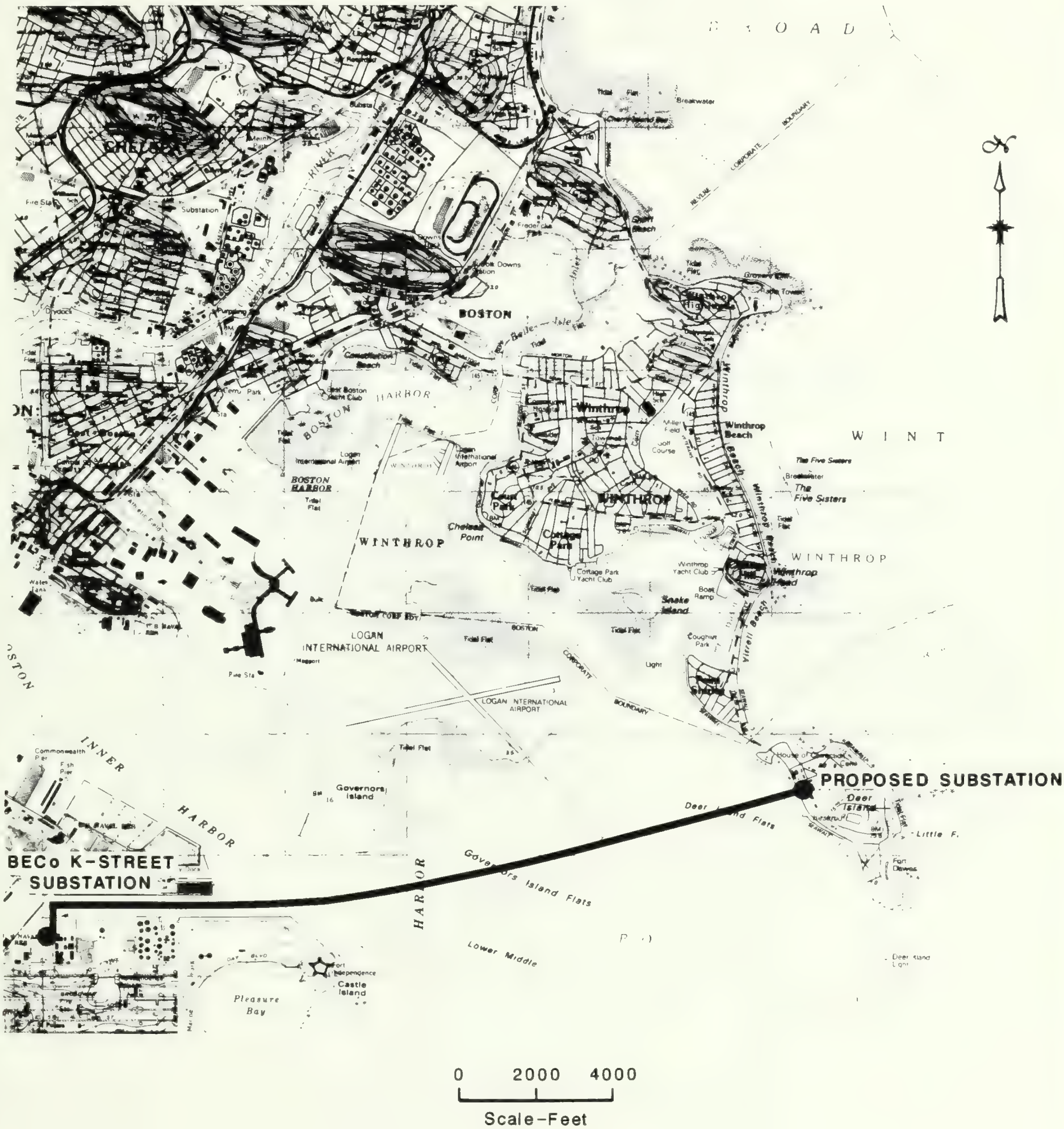
Along the underwater routes, an electric power cable will be installed. Construction requirements for this installation are unique due to the special equipment used to embed the cable. These requirements are discussed in Section 2.5.2.

2.5.1 OVERLAND ROUTES

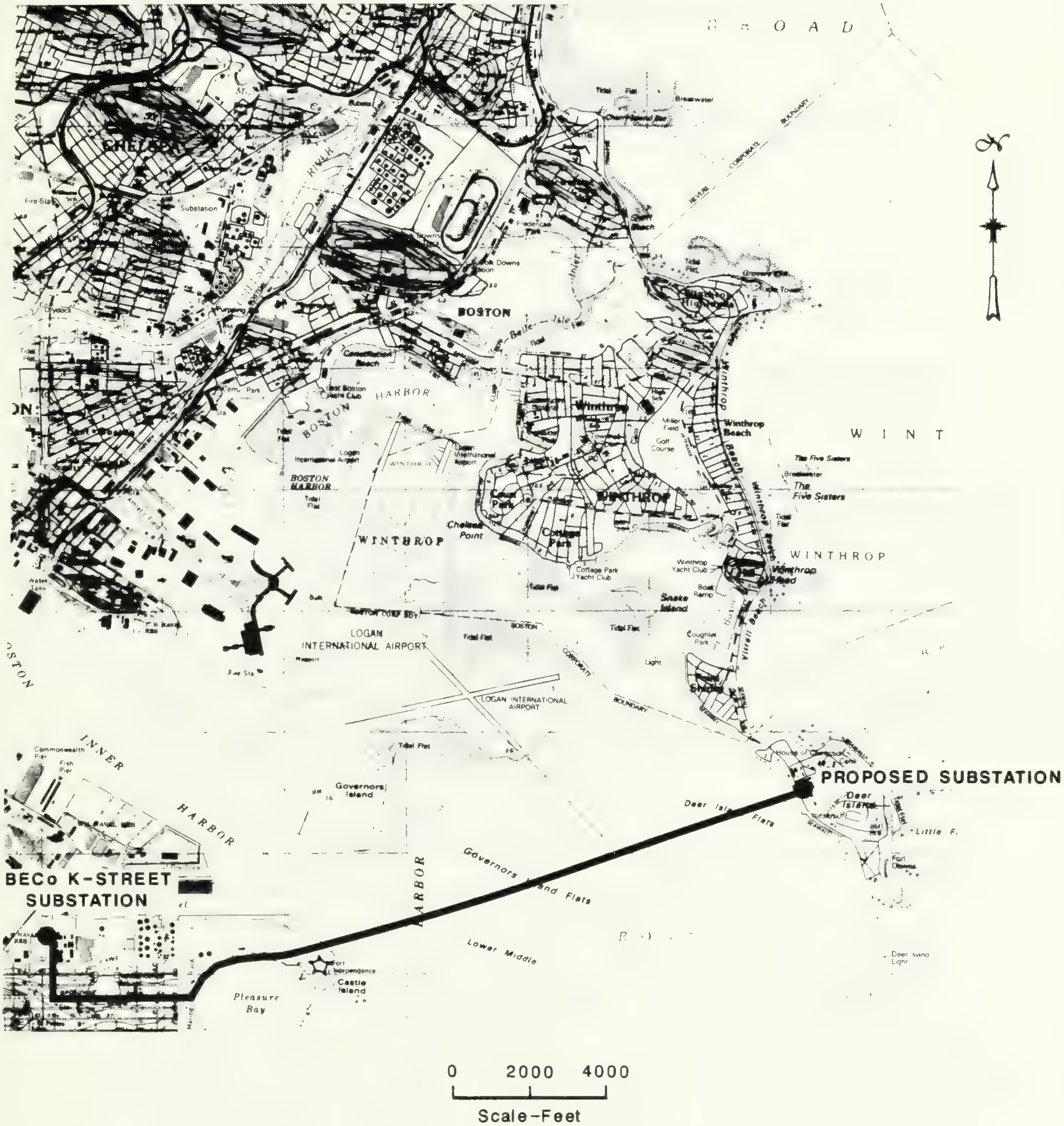
General

The alternative overland routes are described in Section 2.4. These routes are primarily along roadways or beaches.

For facilities planning purposes, it is assumed that all utilities will be installed in the same trench during the same time period. This will minimize traffic and noise impacts to the community and result in the most economical installation. The feasibility of a common trench will be confirmed during final design. Field surveys to determine the location of existing utilities (water, gas, electric, sewer, telephone, and cable television) must be performed at that time. With this information, the location of the new water, gas, and electric utilities



MASSACHUSETTS WATER RESOURCES AUTHORITY	FIGURE 2.4.4-1 ALTERNATE ROUTE S-1



MASSACHUSETTS WATER RESOURCES AUTHORITY

FIGURE 2.4.4-2
ALTERNATE ROUTE S-2

will be finalized. If it is determined that separate trenches are required, this work could be performed concurrently by the same contractor.

It is likely that existing water, gas, and sewer connections to customers will be frequently crossed by the new utilities. During final design it will be determined whether existing connections can remain in place or if they need to be replaced. Temporary disruption to existing water and gas services may be required during construction.

Trench Section - Roadway

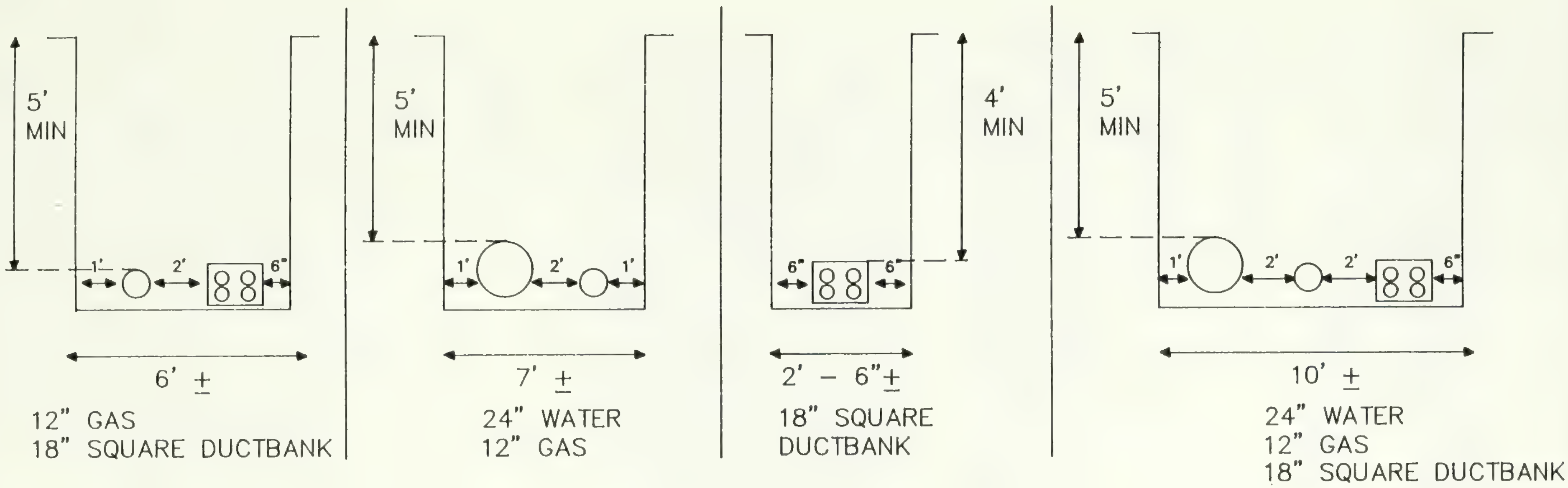
New utilities will be installed according to applicable codes and standards. Suitable clearances between new and existing utilities will be provided to allow for maintenance.

Typical trench sections for the various combinations of utilities are shown in Figure 2.5.1-1. Trench widths and depths depend on the type and number of utilities to be installed. Typical construction requirements for the three utilities are as follows:

Water - The 24 inch diameter water line will be ductile iron (or equivalent) pipe with push-on joints. A minimum of 1 foot must be allowed between the pipe and the trench wall. A minimum of 2 feet must be allowed between the pipe and other utilities to allow for future maintenance. A minimum of 5 feet of cover should be provided for freeze protection. The water line will be fabricated and installed in accordance with MWRA's requirements.

Gas - The 12 inch diameter gas main will be steel pipe with welded joints. A minimum of 1 foot must be allowed between the pipe and the trench wall. A minimum of 2 feet must be allowed between the pipe and other utilities to allow for future maintenance. A minimum of 5 feet of cover is good engineering practice. The gas main will be fabricated and installed in accordance with Boston Gas Company's requirements.

Electric - The reinforced concrete ductbank, approximately 18 inches square, will contain four 5 inch or larger diameter ducts. Power cables will eventually occupy three of the ducts and control/communication cable will occupy the remaining duct. The ductbank will be either cast-in-place, or it will be pre-cast with cast-in-place joints. For facilities planning purposes, a ductbank has been selected because it can be placed in a common trench by the same contractor installing the water and gas. Then cable can be pulled through at a later date. Standard concrete electrical manholes will be located at intervals of 1000 feet to 1500 feet or as otherwise required to facilitate cable pulling. An alternative to a ductbank system acceptable to BECo for the installation of an underground 115 KV cable is a pipe-type cable, approximately 6 inches in diameter. There are a limited number of contractors approved by BECo to install this system. Therefore, it does not appear to be compatible with the common trench philosophy. If during detailed design it is determined that the electrical cable must be in a separate trench, the pipe-type cable system should be reconsidered because it will require a narrower trench and may be less costly to install.



NOTE 1: MINIMUM COVER OVER WATER AND GAS PIPELINES SHOULD BE 5 FEET ±. MINIMUM COVER OVER DUCTBANK SHOULD BE 4 FEET ± ON BEACH ROUTE, MINIMUM OVER ALL UTILITIES SHOULD BE 8 FEET ±. WARNING INDICATORS (TAPE, MESH, ETC.) NOT SHOWN.

NO SCALE

MASSACHUSETTS WATER RESOURCES AUTHORITY

TRENCH

FIGURE 2.5.1-1

TYPICAL TRENCH SECTIONS
LAND ROUTES

The concrete ductbank requires a minimum of 6 inches between it and the trench wall. A minimum of 2 feet should be allowed between the ductbank and other utilities to allow for future maintenance. The ductbank base should be founded below frost level. This is accomplished by providing a minimum of four feet of cover.

The ductbank will be constructed in accordance with BECo's requirements.

Trench Section - Beach

Several of the alternative routes (N-1, N-1A, N-1D) are adjacent to Winthrop Beach and Yirrell Beach in Winthrop.

Winthrop Beach runs along Ocean Shore Drive, south to Winthrop Head. This beach area is highly erosional. Ocean Shore Drive and nearby property is protected by a seawall. Along Winthrop Beach, the utilities will be buried in a trench along the land side of the seawall. Between the end of Winthrop Shore Drive and Winthrop Head, the trench will be located at the toe of an unstable slope. A utility trenching box or other means of bracing the trench will be required in this area.

Yirrell Beach is located between Winthrop Head and Deer Island. In order to minimize impact to property owners along Yirrell Beach, the utilities will be buried in a trench along the ocean side and adjacent to the seawall. This area is reported to be depositional (Yirrell Beach Coastal Processes Study: Winthrop, Massachusetts, Technical Report No.1, June 1979. Duncan Fitzgerald, et al., Boston University Department of Geology). A review of the literature indicates that the utilities will be safe from storm damage provided that they are all located adjacent to the seawall. A more detailed investigation will be conducted during detailed design in order to establish final design criteria for storm protection, burial depth, and cover. For conceptual design, the minimum depth of cover was increased to eight feet along the beach. All other trench requirements are similar to those in roadways, as shown on Figure 2.5.1-1.

Construction Sequence

Installation of utilities along the roadway routes will follow standard utility procedures:

1. Cut the pavement and excavate trench to the desired width and depth.

2. Place gravel bedding along the trench bottom to provide firm and uniform support.

3. Place utility sections in the trench and join together.

4. Backfill the trench with suitable material to the desired density.

5. Place a temporary asphalt patch over the trench.

6. If required, complete a permanent curb to curb asphalt overlay at a later date.

Along the beach routes, the construction sequence will be similar to the roadway. However, restoration of the beach to pre-construction conditions will be a priority. It will be a requirement to backfill the trench with material in the reverse order it was excavated.

Special Considerations

During detailed design it may be necessary to give special consideration to certain excavations. These are discussed in general terms below:

a) For trench excavation up to 8 ft deep adjacent to shallow embedded foundations (less than 3 ft depth below ground surface), maintain lateral distance of 10 ft from the foundation wall.

b) For trench excavation up to 8 ft deep adjacent to moderately deep embedded foundations (6 to 8 ft depth below ground surface), maintain a minimum lateral distance of 5 ft from the foundation wall.

c) For trench excavation up to 10 ft deep adjacent to seawall, maintain sufficient distance to keep from undermining the seawall.

d) For trench excavation along the toe of the unstable slope along Winthrop Beach, minimize the length of trench left open.

e) If wellpoint dewatering is required along any section of the trench, close monitoring of the adjacent structures should be established.

f) Consideration should be given to a preconstruction evaluation of structures along portions of the trench routing where the excavation comes to within 20 ft of the structure, where dewatering is required, or where the structure may be particularly sensitive to construction activity or have unusual historic value.

2.5.2 UNDERWATER ROUTES

General

The alternative underwater routes are described in Section 2.4. Electric power is the only utility which will be installed underwater. Each service will consist of three cables buried in a trench.

The cable routes either cross or run adjacent to the main Boston Harbor shipping channel and an anchorage area. In these areas, the cables could be highly susceptible to damage, primarily by anchor dragging. To protect the cables, it will be necessary to bury them.

Several construction methods could be employed. The preferred method is to embed the cables into a narrow trench. This method provides maximum protection for the cables and causes minimal disturbance of sediments.

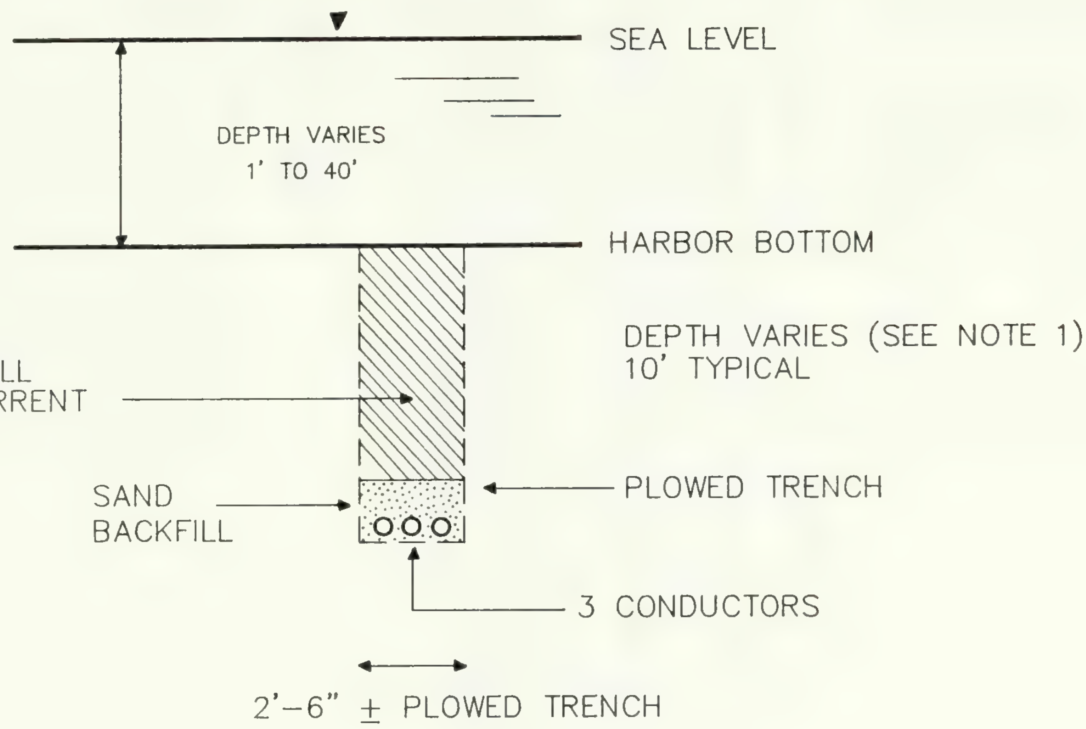
Trench Section

A typical trench section for an underwater cable installation is shown on Figure 2.5.2-1.

One 2 ft 6 inch wide trench with three conductors embedded in a horizontal alignment, with 10 feet of cover is shown as a typical section. Typically, underwater cables have been installed with either three or four (one spare) conductors. Four conductors have been used when it is necessary to keep the power in service if one conductor fails. With four conductors, if each is installed in a separate trench with suitable separation, it would be possible to retrieve and repair one cable without disturbing the others. However, installing each cable in a separate trench is much more costly than a common trench installation and the environmental impacts are greater.

Based on discussions with BECo, the cables are very reliable, and not expected to fail unless damaged by an anchor. Also, it is likely that all cables, if placed within one trench, would be damaged by a postulated anchor dragging accident. Therefore, four cables in a common trench (or two trenches each with two cables) appears to be no more reliable than three cables in a common trench. Since the cost and environmental impacts of installing four cables in two separate trenches are substantially higher and the benefits are questionable, the recommendation is to install three conductors in a common trench. Discussions with contractors experienced with underwater cable repair indicate that repairs could be completed within 3 to 4 weeks. Considering that a totally separate and 100 percent redundant source of electrical power will be provided to Deer Island from the north to cover any unforeseen failures, the three cable installation is justified.

Discussions were held with three contractors with experience embedding cable underwater. One contractor recommended installing all three cables in a single trench in a single pass. He recently completed the installation of three 230 kV 5 inch diameter underwater cables in one trench. Each cable weighed 39 pounds per foot. This is larger and heavier cable than the cable needed for Deer Island. The other two contractors were not capable of handling more than two conductors at once and therefore recommended two trenches. One trench is preferred and should be utilized if technically and economically feasible. This will be confirmed when bids are received on the cable installation. Ten feet of cover is indicated as a typical requirement to protect the cable from anchor dragging. Based on a preliminary review of the literature, the penetration depth of an anchor depends on many variables, including type and weight of anchor, sub-bottom material density, anchor pull tension, and entry angle of anchor flukes. Anchor penetration can vary from zero in sound rock to over 25 feet in soft mud. Therefore, a detailed knowledge of the sub-bottom material and the shipping traffic must be known before embedment depth can be finalized. Considering the lack of information at this



NOTE 1: CABLE WILL BE BURIED TO PROVIDE PTOTECTION AGAINST ANCHOR DRAGGING. REQUIRED DEPTH OF TRENCH AND SAND BACKFILL DEPENDS ON LOCATION AND BOTTOM CONDITIONS.

NO SCALE

MASSACHUSETTS WATER RESOURCES AUTHORITY TRENCHU	FIGURE 2.5.2-1 TYPICAL 115KV CABLE TRENCH SECTION UNDERWATER ROUTES

time, BECo has indicated an initial preference to embed the cable a minimum of 10 feet in both sediment and rock.

To obtain the required knowledge of the bottom, the following surveys should be performed along the selected route:

- o Bottom profile
- o Top of rock profile
- o Water depths
- o Magnetometry
- o Sidescan sonar
- o Soil gradation
- o Rock strength

This information must be provided to cable installation contractors when bids are requested.

The following cable description is based on preliminary sizing and discussions with BECo and a cable manufacturer. Dimensions are approximate, and details of construction are subject to change based on final design and the selected manufacturer. The description, however, provides a reasonably accurate description for facilities planning purposes.

The power supply consists of three separate cables. Each cable is four inches in diameter and weighs 20 pounds per foot. At the center of each cable is an oil filled 3/4" diameter hollow steel core. Surrounding the core is a 400-1000 KC mil upper conductor which in turn is surrounded by tape, paper insulation, a lead wall, galvanized steel armor wiring, and a nylon jacket.

Construction Sequence

To date, the sub-bottom surveys required for cable installation have not been performed. Therefore, conditions along the alternative routes are not well known. Based on a review of existing maps, and data provided by the U.S. Army Corps of Engineers, however, it is believed that rock will be encountered. Rock outcroppings are indicated in Governors Island Flats. Also in the main shipping channel rock may be found between 5 and 15 feet below the bottom. Therefore it is nearly certain that the cable must be embedded into the rock in these areas. In order to make allowances for schedule and cost, it is assumed that rock will be encountered along 50 percent of any underwater route.

The following discussion regarding construction equipment and sequencing is based on information provided by Harmstorf Corporation, a contractor specializing in underwater embedment of submarine power cables utilizing a system which injects the cable into a narrow plowed trench. Conventional dredging and underwater excavation is not required.

Two specially equipped barges are required to install the cables. A work barge, 180 feet by 60 feet, has crew accommodations and supports the equipment used to cut the trench and inject the

cables. A second barge, measuring 100 feet by 40 feet, is used to store the cable and feed it to the injector. The barges work in tandem during the cable embedment process.

After award of a contract to install the cable, three months should be allowed for mobilization of the equipment. It is assumed that the cable will be manufactured and delivered to the site as required, a process which requires a minimum of six months. After mobilization, a trial run along the selected route is conducted. During the trial run with the work barge, the first attempt to cut the trench through overburden with a hydro-jet injector will be conducted. The hydro-jet injector is a tool supported from the work barge which can cut a trench 2.5 feet wide (or less). It works in water depths up to 80 feet and trench depths up to 30 feet (Harmstorf utilizes other equipment for deeper conditions). During the trial run, the trench is cut to the desired embedment depth or to the top of rock. Depending on the soils encountered, sand may be placed in the trench to a sufficient depth to allow future cable installation within a protected bed. The hydro-jet can not cut through sound rock. It cuts through the overburden by directional jetting of 15,000 gpm of water at 230 psi. Diesel driven pumps on the work barge, with a combined rating of 3,500 horsepower, provide the energy. This trial run is estimated to require two weeks to complete.

Next, a rock saw is mounted on the end of the injector shoe. With the rock saw mounted, the work barge makes a second pass along the selected route. The saw will cut the trench through rock, up to 3 feet wide and 13 feet deep. As the rock is excavated a sand bedding is placed into the trench from a barge. The saw is powered by a 1,000 horsepower diesel powered hydraulic drive unit located on the work barge. Rock trenching advances at 100 to 200 feet per day. Considering all of the alternative underwater routes, recommended Route S-1 (originating at BECo's K-Street Substation) is the longest at 20,400 feet. Assuming that rock will be encountered along 50 percent of the longest route, and that the advance rate through the rock will be only 100 feet per day, it is conservatively estimated that the rock trenching will take 102 days or 17 weeks. This saw has been used in rock with compressive strengths up to 23,000 psi and it should be suitable for trenching in Boston Harbor. However, this must be confirmed by Field Surveys.

Once the rock trench is completed, the rock saw is removed from the injector shoe. The cable storage barge is then tied in tandem with the work barge and the cable burial process is ready to begin. On the third and final pass, the trench is again hydro-jetted as the three cables are embedded into the sand bed providing at least 1 ft of sand cover over the cable. The remainder of the trench is then allowed to fill in by natural siltation processes.

The construction methods described above are used to install the cable underwater from one shoreline to the other. The barges work close to shore at high tide. Then, at low tide, a conventional backhoe continues the trenching on land. On land, the cable will be buried between 5 feet and 8 feet deep as described in Section 2.5.1.

In its May 1988 Navigation Improvement Study, Feasibility Report and Environmental Assessment, the Corps of Engineers (COE) describes its proposed plans to deepen Boston Harbor. Its plan involves deepening the Reserved Channel and the Main Ship Channel from -35 ft MLW to -40 ft MLW. If approved and funded according to the present schedule, construction would begin in 1993.

Therefore, it will be necessary to carefully coordinate the cable embedment depth with the COE to ensure that the integrity of the cable will not be affected by the future dredging project.

The COE has indicated the need for blasting in certain areas. It would be of particular concern should blasting be required in the vicinity of the cable. However, based on a review of preliminary ledge contours developed by the COE, it appears that future rock blasting will not be required near the proposed cable route. Therefore, it should be feasible to embed the cable to sufficient depth such that the future COE project will not impact its integrity. This must be confirmed by the proposed surveys described above under "Trench Section."

2.6 DETAILED EVALUATION CRITERIA

The purpose of this section is to describe the criteria which were used to evaluate the alternative utility routes. These criteria include those which have been employed for screening purposes in the other portions of the Secondary Treatment Facilities Plan, as well as additional criteria applicable to the detailed analysis required for selecting utility routes. Table 2.6-1 provides a summary of the criteria used to evaluate the alternative utility routes, along with the rating for each criterion.

2.6.1 TECHNICAL CRITERIA

Constructibility

Constructibility takes into account many aspects of the construction along the alternative utility supply routes. These include the degree of construction difficulty, construction duration, and impacts on overall scheduling. Construction work is divided into appropriate packages, depending on factors such as special labor skills required, marine vs. on-land activities, etc. For this study, utility routes are rated as presenting "difficult" or "normal" conditions for construction.

Reliability

Reliability is defined as the degree to which an alternative utility route will be able to consistently provide electrical power, gas and potable water throughout the operating life of the Deer Island treatment facilities. Utility route alternatives are rated using one of two levels of reliability: "acceptable" and "high." An alternative ranked "high" has a lower risk associated with potential line failure than an alternative rated as "acceptable." In all cases, alternatives ranked "acceptable" will have backup electrical power available from both on-island generation and other off-island utility supplies.

Capital Costs

Capital costs of alternatives include costs to construct the required utility supply routes and costs for equipment replacement during the planning period, plus 35 percent to cover construction contingencies, administrative, engineering and legal costs. Any significant and

TABLE 2.6-1

SUMMARY OF EVALUATION CRITERIA
FOR UTILITY ROUTE EVALUATION

Evaluation Criteria	RATING		
Technical Criteria:			
Constructibility	difficult	normal	-
Reliability	-	acceptable	high
Capital Costs	millions of dollars		
Timely Implementation	difficult	moderate	-
Environmental Criteria:			
Land Resources	significant	moderate	minimal
Traffic	length of construction in roadways, feet		
	length of roadway restricted to less than two lanes during construction, feet		
Noise Control	projected noise, dBA		
	construction progress rate		
	total length of route having sensitive receptors, feet		
Marine Resources	significant	moderate	minimal
Marine Archaeology	poor	average	excellent
Institutional Criteria:			
Permitting	extensive	moderate	-
External Coordination Requirements	extensive	moderate	minimal
Internal Coordination Requirements	extensive	moderate	minimal
Demand for Unique or Scarce Resources	difficult	moderate	-

special impact mitigation cost is included in the alternative costs. Construction costs of necessary facilities in this plan do not include costs for land purchase. Financing, legal and administrative costs to implement the project are presented only for the recommended plan. Capital costs are presented in terms of millions of dollars.

Timely Implementation

Implementation is defined as the relative difficulty expected in maintaining the schedule for installation and/or expansion of the system in discrete, manageable components. For this study, two ratings are appropriate for this criterion: "difficult" and "moderate". For alternatives with features likely to make implementation difficult or to cause project delays, the "difficult" rating is used. For other alternatives with fewer challenges, the "moderate" rating is used.

2.6.2 ENVIRONMENTAL CRITERIA

None of the utility route alternatives involve a potential to generate odors or air emissions, either as a consequence of the associated construction of the routes, or during the operating lifetime of the utility supplies. Therefore, air emissions control criteria were not included in the evaluation of alternative utility routes.

Land Resources

This criterion measures a project component's effect on selected, land-based environmental resources. Together with the previous environmental criteria, the list below is based on EPA guidance for facilities planning, and includes the following considerations:

- Historic and archaeological sites
- Floodplains and Wetlands
- Terrestrial ecology, including wildlife protection and endangered species protection
- Parks and recreational resources

Alternatives are rated as having "minimal," "moderate," or "significant" effect.

Traffic

MWRA has committed to limiting the traffic through Winthrop during both construction and operation of the treatment facilities. Major elements of that commitment include construction of the pier facilities, over-water transport of at least one-half of the construction workers and virtually all construction equipment and materials, and bussing of the remaining construction workers from satellite parking locations. Construction of the alternative utility supply routes may temporarily affect existing traffic movements along the utility routes. Impacts associated with the number of workers and construction vehicles required for construction of each alternative supply route are essentially the same.

To reflect the above considerations, two estimators of potential traffic impacts were used: The total length of construction in roadways was estimated, and the total length of roadway restricted to less than two lanes during construction was estimated for each route.

Noise Control

MWRA has committed to complying with stringent noise mitigation criteria by developing a program to avoid adverse noise impacts during construction and operation. Construction of the off-island utility supply routes will, however, generate noise in locations where mitigating strategies operative on the Deer Island construction site will not apply. Each of the alternative utility supply routes will employ the same level of noise control during construction. Alternative utility supply routes are rated using criteria which evaluate the level of noise impact, the duration of noise impact which is indicated by construction progress rate, and the total length of the route having sensitive residential and commercial receptors.

Marine Resources

Potential impacts to marine resources associated with the construction of alternative utility supply routes are compared. In general, those alternatives involving construction within or proximate to the marine environment may be characterized as having a "minimal," "moderate," or "significant" potential for either short- and/or long-term impact to the affected resources. Impacts may be direct to the marine biota, such as displacement of biota, or impacts may be indirect, such as the release of potential contaminants, including turbidity. This criterion also includes the potential for impacting endangered marine wildlife or important habitats such as wetlands, shellfish beds or spawning areas.

Marine Archaeology

This criterion measures the potential impacts that alternative submarine utility supply routes might have on historic/archaeological areas within the study area. Alternatives are rated "excellent," "average," or "poor," based on the likelihood of the existence of historic/archaeological submarine resources proximate to the submarine utility routes.

2.6.3 INSTITUTIONAL CRITERIA

Permitting

Permitting is defined as the measure of the relative difficulty in obtaining the necessary permits for an alternative. The alternatives are rated "moderate" or "extensive" reflecting the relative time required to obtain the requisite permits.

External Coordination Requirements

External coordination requirements are a measure of the relative degree to which the MWRA must interact with other organizations to achieve the desired objectives. This includes

consideration of legislative approval and other requirements necessitated by legal and jurisdictional limits to MWRA's authority. Alternatives are rated "minimal", "moderate," or "extensive," depending on the degree of coordination required.

Internal Coordination Requirements

Internal coordination requirements are a measure of the relative degree of coordination required between MWRA project or programs such as the coordination between the MWRA's wastewater treatment section and the water supply section. Alternative routes are rated "minimal," "moderate," or "extensive," depending on the degree of coordination required.

Demand for Unique or Scarce Resources

This criterion is a measure of the demand that any one alternative may put on resources that are in scarce supply or not available in the local area. Key shortages of some labor skills and equipment may occur because of the concurrent construction of major projects such as the third harbor tunnel. Alternative utility routes are rated "moderate" if potential conflicts exist, or "difficult" if demands clearly exceed supply.

3.0 EXISTING CONDITIONS

3.1 LAND RESOURCES - LAND USE

3.1.1 POTABLE WATER, NATURAL GAS AND PERMANENT POWER - NORTHERN ROUTES

Existing land use along Routes N-1, N-1A, N-1B, N-1C and N-1D can be characterized generally as densely developed urban residential and commercial with interspersed pockets of open space and beach.

The utility lines will be located primarily within the streets; however, for approximately 7,100 feet, Routes N-1 and N-1A run along the beach and for approximately 4,500 feet, Route N-1D runs along the beach.

The southern most portion of the routes are residential and open space beach with an occasional commercial establishment. Along Shirley Street, near Tewksbury Street, a commercial district is located; it continues along Veterans Road (Route N-1B) and is interspersed with residences. The entire west side of Veterans Road is comprised of 5 recreational areas. Winthrop Shore Drive (Routes N-1, N-1A, N-1C, N-1D) is primarily residential on the west side of the street and Winthrop Beach abuts the east side of the street. Crest Ave (N-1, N-1C) is primarily commercial along the south side of the street and commercial and recreational along the north side of the street. Locust Street (Routes N-1A and N-1D) and Tewksbury Street (N-1C) are residential streets. From Revere Street north along the route to Eastern Avenue (N1, N-1A, N-1B, N-1C, N-1D), land uses are mixed residential and commercial. Uses along Eastern Avenue are commercial and industrial.

3.1.2 PERMANENT POWER - NORTHERN ROUTE

Route N-2 also begins at the BECo Chelsea Substation and runs south along Eastern Avenue and Marginal Street which have primarily industrial uses. It continues across Chelsea Creek into East Boston where it traverses a primarily urban residential and commercially developed area. The only cross-country portion of this route crosses the Massachusetts Bay Transportation Authority (MBTA) tracks to Orient Heights Beach, a recreational area, and then travels under water across Boston Harbor to Deer Island.

3.1.3 INTERIM AND PERMANENT POWER - SOUTHERN ROUTES

Southern Route

Route S-1 and Route S-2 originate at the K-Street Substation in South Boston. Route S-1 heads briefly north across industrial property and then under water through the Reserved Channel and across Boston Harbor.

Route S-2 travels primarily through urban residential and commercial areas in South Boston and abuts some open space areas. The utility lines will remain within the boundaries of the streets along most of this route.

3.2 LAND RESOURCES - PARKS AND RECREATIONAL AREAS

The proposed utility lines will pass through densely developed urbanized areas in five communities: Winthrop; Revere; Chelsea; East Boston; and South Boston. Along these routes lie several developed parks, recreational areas and open space. Each park and recreational area abutting a proposed utility route is listed below. The areas are keyed numerically to Figure 3.2-1.

1. American Legion Playground - This playground is located on Condor and Glendon Streets in East Boston. Facilities at this park include a ballfield as well as other playground equipment. There is also an early 20th century recreation building on the site which is a potential historic resource. Route N-2 passes by this park.

2. Constitution Beach (Orient Heights Beach) - This Metropolitan District Commission (MDC) operated recreational area is located on Boston Harbor in East Boston. Facilities at the park include an athletic field, tennis courts, skating rink, swimming area and a children's playground. Route N-2 crosses this area.

3. Merritt Park - This Park is located on Eastern Avenue in Chelsea. It is maintained by the City of Chelsea. Facilities at the park include a basketball court, tennis courts, a baseball field, and benches for passive recreation. Routes N-1, N-1A, N-1B, N-1C and N-1D pass by this park.

4. Suffolk Downs Racetrack - The racetrack is located on Winthrop Avenue (Route 145) and Bennington Street in Revere and East Boston. This area attracts large crowds for horse racing events. Races are generally held every afternoon except on Tuesdays and Thursday. Routes N-1, N-1A, N-1B, N-1C and N-1D pass by the racetrack.

5. Crest Avenue Playground - This area is located on Crest Avenue in Winthrop. Facilities at the park include a children's play area, a basketball court and benches for passive recreation. Also located at this site is a World War Memorial. Routes N-1 and N-1C pass by this area.

6. Winthrop Beach - This beach, located along Winthrop Shore Drive in Winthrop, is under the jurisdiction of the MDC. Routes N-1, N-1A, N-1C and N-1D pass by this beach.

7. Yirrell Beach - This beach is located along Shirley Street in Winthrop is maintained by the Town of Winthrop. Routes N-1, N-1A, and N-1D pass through this beach, and Routes N-1B and N-1C travel on Shirley Street adjacent to the beach.

LEGEND

1. American Legion Playground
2. Constitution Beach
3. Merritt Park
4. Suffolk Downs Race Track
5. Crest Avenue Playground
6. Winthrop Beach
7. Yirrell Beach
8. Lewis Lake Park
9. Norman Daw Playground
10. Winthrop Golf Club
11. Miller Field
12. Winthrop Little League Field
13. Marine Park
14. Fort Independence Park
15. Christopher Lee Playground

0 2000 4000
Scale-Feet

MASSACHUSETTS WATER RESOURCES AUTHORITY	FIGURE 3.2-1 EXISTING PARKS AND RECREATIONAL AREAS

Along Veterans Road north of Washington Street and South of Shirley Street there are five recreational areas:

8. Lewis Lake Park - This is the southern most park, and is adjacent to Washington Street. This area affords a small lake, marshes and lawn for passive recreation.

9. Norman Daw Playground - This small children's playground is located adjacent to Veterans Road, north of Lewis Lake Park.

10. Winthrop Golf Club - The club is located between Veterans Road and Cross Road and is a 9-hole private course.

11. Miller Field - This area located north of the golf course is the track and athletic field for Winthrop High School.

12. Winthrop Little League Field - This facility is located just north of Miller Field adjacent to Veterans Road.

Route N-1B passes by recreational areas 8 through 12.

13. Marine Park and 14. Fort Independence Park - These parks are located along Day Boulevard in South Boston, and are maintained and operated by the MDC. Facilities include a boat landing, an athletic field, an ice skating rink, a children's playground, a picnic area, tennis courts, a beach, an historic site (Fort Independence), and benches and walkways for passive recreation. Route S-2 passes by these areas.

15. Christopher Lee Playground - This park and athletic field is bounded by 1st Street, M Street, Broadway and Leonard Street in South Boston. Route S-2 passes by this area.

3.2.1 POTABLE WATER, NATURAL GAS AND PERMANENT POWER - NORTHERN ROUTES

Routes N-1, N-1A, N-1B, N-1C and N-1D carry electricity by Merritt Park in Chelsea. In addition, all of these routes carry electricity and gas by the Suffolk Downs Race Track. Routes N-1, N-1A, N-1C and N-1D carry electricity, water and gas in the road by Winthrop Beach. Routes N-1, N-1A and N-1D traverse Yirrell Beach with electricity, water and gas lines while Routes N-1B, and N-1C pass by the beach in Shirley Street. Routes N-1 and N-1C pass by the Crest Avenue Playground. Route N-1B carries electricity, water and gas by the five recreational areas which abut Veterans Road: Lewis Lake Park; Norman Daw Playground; Winthrop Golf Club; Miller Field; and Winthrop Little League Field.

3.2.2 PERMANENT POWER - NORTHERN ROUTE

Route N-2 carries a 115kv electrical line by the American Legion Playground in East Boston. In

addition, this route traverses the MDC operated Constitutional Beach, also located in East Boston.

3.2.3 INTERIM AND PERMANENT POWER - SOUTHERN ROUTES

Route S-1 does not pass by any parks or recreational areas. Route S-2, however, carries electricity by the Christopher Lee Playground and Marine Park in South Boston and traverses the property of Fort Independence.

3.3 LAND RESOURCES-TERRESTRIAL ECOLOGICAL RESOURCES

3.3.1 POTABLE WATER, NATURAL GAS AND PERMANENT POWER - NORTHERN ROUTES

The proposed mixed utility routes N1, N-1A, N-1B, N-1C and N-1D from BECo's Chelsea Substation to Deer Island are described in Section 2.4.2. For the most part, each of the alternative routes follows existing roadways, and terrestrial ecological resources along these routes consist primarily of native and ornamental shade trees. No unique or rare plant or animal species were observed along these routes.

Three of the mixed utility options, N-1, N-1A, and N-1D propose to utilize Yirrell Beach in Winthrop. Yirrell Beach, as described in Section 3.8.1 under Marine Resources, is a broad, rather flat beach which extends from the southern tip of Winthrop Head to Deer Island. The majority of the beach is cobble and devoid of vegetation. However, the southern end of the beach at the point where the seawall ends and extending toward Deer Island has scattered clumps of vegetation (refer to Section 3.8.1).

All of the proposed mixed utility routes from the Chelsea substation will necessitate crossing Mill Creek. The Mill Creek crossing will be accomplished using the existing bridge, thus no wetland or stream border habitat which may be present in this area will be disturbed.

3.3.2 PERMANENT POWER - NORTHERN ROUTE

The permanent power route alternative N-2 is described in Section 2.4.3. Route N-2 is a combination of overland and submarine route from the Chelsea Substation. The submarine route is described in Section 3.8.2, under Marine Resources. The overland portion of N-2 follows existing roadways to a great extent. No unique or rare plant or animal communities were observed along this route, a portion of which traverses a heavily industrialized area. Native and ornamental shade trees are present along stretches of the route.

The overland portion of Route N-2 ends at Orient Heights Beach, as described in Section 3.8.2. The Orient Heights Beach area has grassed parcels and some ornamental plantings. No extensive wetland or intertidal vegetation is present along the beach, which was visited at mid-tide.

The proposed route will cross Chelsea River. This will be accomplished by utilizing an existing stream crossing conduit, terminating in manholes in roadways on either side of the

river; thus, there is no adverse impact on any wetland or stream border habitat that may be present in the area.

The area west of the crossing is adjacent to a parcel of land designated as Chelsea Conservation Land. This area does support wetland vegetation in the form of common reed (Phraqmites communis), cattail (Typha sp.), grasses and along the perimeter, tree-of-heaven (Ailanthus altissima).

3.3.3 INTERIM AND PERMANENT POWER - SOUTHERN ROUTES

The interim and permanent power Routes S-1 and S-2 are described in Section 2.4.4. There are several overland options for Route S-1 from the K-Street Substation to the Reserved Channel. The first option, shown on Figure 2.4.4-1, is for the power cable to traverse an abandoned open field directly to the channel. This field has scattered vegetation, mostly grasses and perennial forbs such as ragweed (Ambrosia artemisiifolia), red clover (Trifolium pratense), wild carot (Daucus carota) and, along the margins shrubs, saplings and trees such as tree-of-heaven (Ailanthus altissima). The route then enters the Fort Point Channel west of the Summer Street Bridge. The intertidal area at this point, which is described in Section 3.8.3 under marine resources, appears degraded. Debris litters the area and there was a sulphur-yellow rime along the margins. The only vegetation in the intertidal area were dense clumps of rockweed (Fucus sp.) attached to the riprap. In addition, the waters in this embayment had a sheen of oil, indicating contamination.

The second option for S-1 is to follow Elkins Street from the substation, across Summer Street to the New Boston Station parking lot and then directly into the channel. No vegetation is present along this route except at the end of the parking lot where several small oak trees are present along with some grasses and forbs.

Alternative Route S-2 follows existing roadways from the K-Street Substation to East Broadway, thence to William J. Day Boulevard to Fort Independence. Along East Broadway and William J. Day Boulevard, native and ornamental trees are present.

At Fort Independence (Castle Island), the proposed route will follow the fence separating the Sealand Terminal from the Castle Island property. This area has recently been landscaped to provide a Harbor View and supports grass and ornamental tree plantings. No unique or important biological communities were observed along this route.

3.4 LAND RESOURCES-WETLANDS AND FLOODPLAINS

Freshwater and tidal wetlands in Massachusetts are protected under the Wetlands Protection Act (310 CMR 10). Alteration, removal or disturbance of these habitats is prohibited. In addition, construction within 100 feet of the 100 year floodplain is prohibited without an Order of Conditions issued by the local Conservation Commission.

3.4.1 POTABLE WATER, NATURAL GAS AND PERMANENT POWER - NORTHERN ROUTES

Portions of each of the northern mixed utility routes are within the 100 year floodplain, as described below.

Route N-1

Within the Revere town boundary, the Mill Creek section of Broadway to Route 16 is within the 100-year floodplain. Also, portions of Winthrop Parkway (Rt 145) near the Suffolk Downs Access Road, and along Short Beach are within the floodplain.

Within the Town of Winthrop, a small portion of Winthrop Avenue (about 500 ft) near the Revere/Winthrop town boundary is within the floodplain. Also, all of Winthrop Shore Drive from Crest Avenue down to Winthrop Head near Beacon Street is within the designated floodplain. In addition, Yirrell Beach lies within the floodplain.

Route N-1A

Route N-1A is essentially the same as Route N-1 with the exception of utilizing Revere Street to Locust Street to avoid Crest Avenue. A small portion of Locust Street (about 500 ft) is within the 100 year floodplain.

Route N-1B

Route N-1B utilizes the Deer Island Truck route which follows Revere Street to Shirley Street, then proceeds south on Veterans Road before returning to Shirley Street via Washington Street and finally to Tafts Avenue to Deer Island. All of this proposed route is within the 100 year floodplain, except for Revere Street and a small portion (about 2200 ft) of Shirley Street and Tafts Avenue, which are within the 500-year floodplain.

Route N-1C

This route is the same as Route N-1 until it reaches Tewksbury Street located north of Cottage Hill. Both Tewksbury Street and Shirley Street near Cottage Hill are within the 100 year floodplain. Further south, Shirley Street and Tafts Avenue are within the 500 yr floodplain zone.

Route N-1D

Route N-1D is essentially the same as N-1A up to Adams Street, which is located at the southern end of Yirrell Beach. This route utilizes Adams Street to Tafts Avenue to avoid further disturbance of the beach. Both of these streets are within the 500 year floodplain, but not the 100 year floodplain boundary.

3.4.2 PERMANENT POWER - NORTHERN ROUTE

The majority of the permanent power route N-2 from Chelsea Substation to Deer Island is within the 100 year floodplain. Specifically, the submarine portion of the route from Orient Heights Beach to Deer Island lies within the floodplain. In addition, Orient Heights Beach contains marginal intertidal wetlands, as described in Section 3.8.2.

3.4.3 INTERIM AND PERMANENT POWER - SOUTHERN ROUTES

The submarine portions of the 115 kV power line (Routes S-1 and S-2) are within the 100 year floodplain. In addition, Route S-2, as it proceeds along Day Boulevard to Fort Independence is within the floodplain.

Route S-1, at the point where it enters the Reserved Channel crosses a steep intertidal area. There is minimal tidal habitat in this area and it appears to be badly degraded, as described in Sections 3.3.3 and 3.8.3.

An intertidal area is also present adjacent to Fort Independence between the Sealand Terminal and the fishing pier. This intertidal area, as described in Section 3.8.3, supports species typical of a rocky coastal community.

3.5 LAND RESOURCES - HISTORIC AND ARCHAEOLOGICAL RESOURCES

Information on historic sites was gathered by means of field inspection of the routes as well as a review of the State Register of Historic Places, Reconnaissance Survey Reports published by the Massachusetts Historical Commission (MHC), and maps and inventory forms on file at the MHC. Of the areas examined, MHC documentation indicates that South Boston has been surveyed intensively, Revere and Chelsea have been surveyed selectively in areas where historic buildings are concentrated, and Winthrop and East Boston have not been surveyed. By means of the field inspection and review of available sources, known historic sites have been identified, and potential resources located. Since the level of impacts along the route of the utility lines is for the most part low, extensive research on potential sites was not pursued.

A preliminary archaeological survey was conducted. The proposed routes are primarily within existing roadways. These segments have already been extensively modified by modern activities including cutting, filling, placement of utilities and paving. The proposed trenches for the new utility lines will not exceed seven feet in depth below the current ground surface; this depth is believed to coincide with extant disturbance levels.

Areas of potential historic and prehistoric archaeological sensitivity may exist elsewhere along the proposed alternative routes in areas such as shoreline and open locations where the effects of modern land use are believed to be limited and resources may be preserved intact. These areas have been identified through surface inspections only.

Figure 3.5-1 presents the locations of identified historic and archaeological resources. A description of the sites can be found in the following sections.

3.5.1 POTABLE WATER, NATURAL GAS AND PERMANENT POWER - NORTHERN ROUTES

Route N-1 and its alternatives (N-1A through N-1D) travel through Chelsea, Revere and Winthrop. One historic site identified in Chelsea is the Mary C. Burke School, located on Spencer Avenue. It is an 1881 Tudor-style public school which survived the fire of 1908. There are several historic sites in Revere. The 1734 Slade Spice Mill, located on Revere Beach Parkway, is a three-story timber structure which is listed on the National Register of Historic Places. The Battle of Chelsea Creek Site is the site of the second battle of the American Revolution, May 27, 1775, and is located on Revere Beach Parkway. In addition, there are three buildings on Winthrop Avenue: the 1920s Tudor-style Fire Station; St. Paul's Episcopal Church, an 1887 stone and wood church; and Trinity Congregational Church, an 1882 timber structure.

Several archaeological sites are located in Chelsea and Revere along Route N-1 and its alternates. Mill Creek is located in Chelsea and Revere and is crossed by Broadway. Possible resources are historic or prehistoric stream banking loci. In Revere, the Battle of Chelsea Creek Site is located along the stream bank between the Revere Beach Parkway and the stream. Possible resources are historic artifacts from the battle site. Sales Creek also located in Revere is on Revere Beach Parkway where the Parkway crosses over Sales Creek. Possible resources are historic or prehistoric stream banking loci.

There are no identified historic sites in Winthrop along Routes N-1 and N-1A.

Along Winthrop Shore Drive at the seawall (Routes N-1 and N-1A) is an open beach margin, presumably disturbed by construction of the sea wall. Possible archaeological resources are dispersed prehistoric or historic loci on open beach. Also in Winthrop is the location at the Shirley Point connection to Deer Island. Possible resources are prehistoric loci on the shoreline.

Along Route N-1B, south of Crest Avenue there are two identified historic resources. The Deane Winthrop House, located at 40 Shirley Street, is a 1637 woodframe house which is included in the Thematic Survey of First Period Houses in Eastern Massachusetts, on file at the MHC. This site is pending nomination to the National Register. The Winthrop Yacht Club, located on Shirley Street, is a 1904 shingle-style building designed by Willard Bacon. There are no identified historic resources on Veterans Road or Tafts Avenue and no identified archaeological sites along this section of the route.

There are no identified historic or archaeological resources along Locust Street (Route N-1A).

Tewksbury Street has one identified historic resource (Route N-1C). The Union Congregational Church located at 22 Tewksbury Street is a late 19th century building of masonry and timber, with a tower. There are no identified archaeological sites on Tewksbury Street.

LEGEND

HISTORICAL RESOURCES

1. Mary C. Burke School
2. Slade Spice Mill
3. Battle of Chelsea Creek Site
4. Fire Station
5. St. Paul's Episcopal Church
6. Trinity Congregational Church
7. Deane Winthrop House
8. Winthrop Yacht Club
9. Union Congregational Church
10. American Legion Playground
11. House (360 Bennington Street)
12. Bennington Street Cemetery
13. St. Mary's Star of the Sea School
14. Pilgrim Hall
15. Harrison Loring House
16. Independence Square Residential District
17. City Point District
18. Castle Island Waterfront District
19. Fort Independence

POTENTIAL ARCHAEOLOGICAL RESOURCES

A. Mill Creek
B. Battle of Chelsea Creek Site
C. Sales Creek
D. Winthrop Shore Drive at Sea Wall
E. Shirley Point (Ea+b)
F. Chelsea Creek
G. Orient Heights Beach
H. Reserved Channel
I. Pleasure Bay Beach
J. Fort Independence

MASSACHUSETTS WATER RESOURCES AUTHORITY	FIGURE 3.5-1 HISTORICAL AND ARCHAEOLOGICAL RESOURCES

3.5.2 PERMANENT POWER - NORTHERN ROUTE

Route N-2 runs through Chelsea and East Boston and across Boston Harbor. There are no identified historic resources along the route in Chelsea; however, several potential historic resources were identified in East Boston. The American Legion Playground, located on Condor and Glendon Streets, is an early 20th century brick recreational building and playground. There is an early 19th century two and a half story timber frame house located at 360 Bennington Street. The Bennington Street Cemetery is an 1838 historic cemetery with immigrant associations and is located on Bennington Street on the corner of Swift Street. St. Mary's Star of the Sea School is a late 19th century brick church complex located at 50, 58, 60 Moore Street on the corner of Bennington Street.

Identified potential archaeological resource sites along Route N-2 include the Chelsea Creek and the Orient Heights Beach. The Chelsea Creek location is at the crossing of the river from Marginal Street in Chelsea to Condor Street in East Boston and includes the wharf as well as filled areas on the flats in this highly industrialized setting. Possible resources are historic wharves or piers and prehistoric loci on the former shoreline.

The Orient Heights Beach location in East Boston transects a filled parking lot and the beach area to the water. Possible resources are prehistoric or historic shoreline loci on the filled and natural cove.

3.5.3 INTERIM AND PERMANENT POWER - SOUTHERN ROUTES

Routes S-1 and S-2 begin at the BECo K-Street Substation in South Boston. Route S-1 runs north from the substation into the Reserved Channel and then across Boston Harbor to Deer Island. There are no identified historic resources along this route.

Route S-2 runs south from the substation and along K Street, East Broadway and Day Boulevard to Castle Island and across Boston Harbor to Deer Island. Six potential resources were identified.

Pilgrim Hall, located on East Broadway, is an 1890 mixed-use commercial space with a meeting hall; it is considered a fine example of a Queen Anne/Romanesque Revival masonry building. The Harrison Loring House, also located on East Broadway, is a circa 1864 French-Italianate brick with brownstone trim mansion house and is a Boston Landmark. Independence Square Residential District, bounded roughly by L, East 2nd, N and East 5th Streets, is a late 1850s to 1880s district of row houses and detached mansions grouped around two parks. The district has been recommended as a Boston Landmark District. City Point District, bounded roughly by Farragut Road, East 3rd Street, P Street and East 6th Street, is a 19th and early 20th century district of freestanding mansions and row houses. It has been recommended as a Boston Architectural Conservation District. Castle Island Waterfront District is part of the water frontage stretching approximately two and a half miles from Columbus Park to Castle Island. It has

historical associations with the late 19th century municipal park system designed by Frederick Law Olmsted. All five of these sites and districts are potentially eligible for listing on the National Register of Historic Places.

The sixth site, Fort Independence, located on Castle Island, is an 1801-1809 military fort. It is the oldest continuously used British military fortification in the United States, with antecedents going back to 1634. This site is listed on the National Register and has been recommended for designation as a Boston Landmark.

A potential archaeological site located along Route S-1 is the Reserved Channel. Possible resources are historic walls and wharves.

Along Route S-2, a potential site at Fort Independence is located on the north side of the park in the vicinity of the original seawall. Possible resources are historic walls and deposits at the shoreline associated with repeated fort habitation.

3.6 TRAFFIC

The alternative utility line routes require both land and submarine construction. Since the majority of the utility routing on land will be within the confines of the roadways and disruption of traffic patterns can be expected. The existing characteristics along the proposed routes help define the types of problems that can be anticipated. A description of the alternative routes is contained in Section 2.4. Data on roadway volumes, cartway widths, curbside parking practices and marine traffic were assembled for use in analyzing traffic impacts and describing existing traffic conditions.

Roadway volumes were collected to develop an estimate of the amount of traffic that would be disrupted along a given roadway by utility line construction. State and local governments and planning agencies were contracted to obtain any existing information. Table 3.6-1 summarizes the existing roadway volumes for the roadways potentially affected by this project. Additional data were collected at the intersection of Eastern Avenue and Broadway; the intersection of Eastern Avenue, Marginal Street, Central Avenue and Chelsea Street; and the intersection of Winthrop Avenue, Revere Street and Winthrop Avenue.

Field measurements of roadway widths were also obtained. The measured widths range from 21 feet for roadways traveling through Shirley Point to 74 feet for a section of Neptune Street located between Saratoga Street and Bennington Street. The average cartway width is 36 feet. Table 3.6-2 lists the cartway widths for the roadways which may be affected by the proposed project.

Curbside parking practice along the routes was observed and is summarized in Table 3.6-3. Field observations of Winthrop curbside parking practice during the weeks of October 19, 1987 and April 23, 1988 showed heavy use of available space for about 50 percent of the total route lengths.

TABLE 3.6-1
ROADWAY PEAK HOURLY VEHICLE VOLUMES

Street	Location	Drtn	Peak Vlm	Time	Drtn	Peak Vlm	Time	Drtn	Peak Vlm	Time	Lanes Around Construction
Wm J. Day Blvd btwn I & K	S. Boston	EB	1050	7 AM	WB	1075	3 PM	T	1600	6 PM	Three
K St N of Broadway	S. Boston	NB	60	3 PM	SB	165	4 PM	T	200	4 PM	Four
Broadway E of K	S. Boston	EB	365	2 PM	WB	550	3 PM	T	900	3 PM	Two
Revere Bch Pkwy E of NE Xpres	Revere	EB	1650	4 PM	WB	2950	5 PM	T	4500	5 PM	Two
Revere Bch Pkwy E of N. Shore	Revere	EB	1400	12 PM	WB	1150	8 AM	T	2400	12 PM	Two
Winthrop Ave W of Bennington	Revere	NB	800	6 PM	SB	500	4 PM	T	1300	5 PM	Two
Winthrop Ave * W of Wn Pkwy	Revere	--	----	----	--	---	----	T	414	5 PM	Two
Winthrop Ave * S of Wn Prk	Revere	--	----	----	--	---	----	T	1426	5 PM	Two
Bennington St N of Neptune	E. Boston	EB	970	8 AM	WB	650	4 PM	T	1325	4 PM	Five
Neptune E of Saratoga	E. Boston	EB	600	8 AM	WB	550	5 PM	T	950	5 PM	Six
Saratoga S of Neptune	E. Boston	--	----	----	WB	200	7 AM	T	200	7 AM	Four

TABLE 3 (cont.)

ROADWAY PEAK HOURLY VEHICLE VOLUMES

Street	Location	Drtn	Peak Vlm	Time	Peak Drtn	Vlm	Time	Peak Drtn	Vlm	Time	Lanes Around Construction
Eastern * S of Broadway	Chelsea	--	----	----	--	---	----	T	602	5 PM	Three
Broadway * N of Eastern	Chelsea	--	----	----	--	---	----	T	1228	5 PM	Three
Eastern * N of Marginal	Chelsea	--	----	----	--	---	----	T	1031	5 PM	Four
Marginal * W of Eastern	Chelsea	--	----	----	--	---	----	T	325	5 PM	Three
Crest *	Winthrop	--	----	----	--	---	----	T	644	5 PM	One
Revere * W of Crest	Winthrop	--	----	----	--	---	----	T	617	5 PM	One
Revere * N of Crest	Winthrop	--	----	----	--	---	----	T	1280	5 PM	Two
Shirley * S of Revere	Winthrop	--	----	----	--	---	----	T	455	5 PM	One
Veterans * S of Shirley	Winthrop	--	----	----	--	---	----	T	297	5 PM	One
Washington * E of Veterans	Winthrop	--	----	----	--	---	----	T	702	5 PM	Two
Shirley * S of Washington	Winthrop	--	----	----	--	---	----	T	579	5 PM	One

TABLE 3.6-1 (cont'd)

ROADWAY PEAK HOURLY VEHICLE VOLUMES

Street	Location	Drtn	Peak Vlm	Time	Drtn	Peak Vlm	Time	Peak Drtn	Vlm	Time	Lanes Around Construction
Tafts S of Elliot	Winthrop	SB	80	2 PM	NB	211	12 PM	T	286	12 PM	One
Winthrop Shore Sat Cnt	Winthrop	NB	302	11 PM	SB	378	12 PM	T	633	12 PM	Two
Winthrop Shore Pk Hr Wk	Winthrop	--	----	----	--	---	----	T	678	5 PM	Two

* Peak hour turning movement counts only.

Source: PEER Consultants, P.C., 1988

TABLE 3.6-2

CARTWAY WIDTH MEASUREMENTS

Street	Location	Cross Street One	Cross Street Two	Area Type	Roadway Length	Cartway Width	Service Type	Route
Revere	Winthrop	Upland	Highland	R	1584.0	35.5	W,G,E	N-1 to N-1D
		Highland	Summit	R/C	739.2	34.1		
		Summit	Shirley	R/C	528.0	30.8		
Crest		Grovers	Highland	C	1056.0	25.8	W,G,E	N-1,N-1C
Locust		Revere	Winthrop Shr	R				N-1A
Shirley		Revere	Cross	R/C	792.0	25.8		N-1B
		Cross	Veterans	R	739.3	26.3		
Veterans		Washington	Hadassah	R/C	5544.0	33.3		N-1B
Washington		Elmwood	Shirley	R/C	1056.0	25.0		N-1B
Shirley		Washington	Tewksbury	C	528.0	34.0		N-1B
		Tewksbury	Terrace 1	R/C	792.0	25.7		
		Terrace 1	Terrace 2	R/C	1056.0	41.0		
		Terrace 2	Yrrll Bch	R	52.8	29.9		
		Yirrell Beach	Petrel	R	792.0	32.8		N-1B
		Petrel	Bayview	R	1056.0	25.8		
		Bayview	Tafts	R	52.8	26.0		
Tewksbury		Winthrop Shore	Shirley	R				N-1C
Tafts		Shirley	Elliot	R	264	21.1		N-1B, N-1C
		Elliot	Sea Wall	R	792	21.3		
		Sea Wall	Deer Island	R	792	21.1		

LE (C

CARTWAY WIDTH MEASUREMENTS

Street	Location	Cross Street One	Cross Street Two	Area Type	Roadway Length	Cartway Width	Service Type	Route
Winthrop		Beacon	Veterans	R	5280.0	35.8	W,B,E	N-1B,N-1C,N-1D
Shore		Veterans	Grovers	R	1056.0	34.9		
Winthrop Pkwy	Revere	Upland	Winthrop Ave	R		36.0	G,E	N-1
Winthrop Ave		Winthrop Pkwy	Summer	R	792.0	31.4	G,E	N-1
		Summer	Crescent	C/R	1320.0	31.1		
		Crescent	Bennington	R	950.4	31.4		
		Bennington	Revere Bch Pkwy	C	792.0	33.2		
Revere Bch		Winthrop Ave	Route 16	C	792.0	35.8	G,E	N-1
				R	4224.0	36.3		
Revere Bch		Route 16	Brdwy Off Rap	C	4488.0	35.9	E	N-1
		Brdwy Off Ramp	Broadway	R	1056.0	36.2		
Broadway	Chelsea	Brdwy Off Ramp	Rte 16 E On Rap		1056.0	48.3	E	N-1
		Rt 16 On Ramp	Eastern Ave	C	1584.0	42.3		
Eastern Ave		Broadway	Louis	C/R	1320.0	41.8	E	N-1
		Louis	Gulf Sign	C/R	1320.0	51.7		N-1, N-2
		Gulf Sign	Central	I	2112.0	52.7		N-2
Marginal		Central	Willow	I	3696.0	37.8	E	N-2
Shelby	East Boston	Lexington	Saratoga	C/R	475.2	34.3	E	N-2
Saratoga		Shelby	Neptune	C/R	528.0	48.0	E	N-2

BLE .2 (

CARTWAY WIDTH MEASUREMENTS

Street	Location	Cross Street One	Cross Street Two	Area Type	Roadway Length	Cartway Width	Service Type	Route
Neptune		Saratoga	Bennington	C	158.4	74.3	E	N-2
		Bennington	Frankfurt	R	369.6	24.0		
Bennington		Neptune	Trident	C/R	6072.0	57.0	E	N-2
K Street	South Boston	E 1st	Broadway	R	792.0	34.0	E	S-2
E. Broadway		K	L	C	686.4	60.7	E	S-2
		L	Farragut	R	3432.0	49.8		
		Farragut	WM J Day		105.6	49.8		

Source: PEER Consultants, P.C., 1987, 1988; See Appendix A.

TABLE 3.6-3
CURBSIDE PARKING PRACTICE

Street	Cross Street One	Cross Street Two	Area Type	Location	Side A Parking Yes/No	% Prkng	Side B Parking Yes/No	& Prkng	Side A & Prkng	Side B & Prkng
Revere	Upland	Highland	R	Winthrop	Yes	15%	Yes	0%	25%	50%
	Highland	Summit	R/C		No sign	0%	No sign	0%	0%	0%
	Summit	Shirley	R/C		Yes	10%	Yes	60%	5%	20%
Crest	Grovers	Highland	C		No		Yes	80%		95%
Locust	Revere	Winthrop Shore	R		Yes	50%	Yes	50%	40%	40%
Shirley	Revere	Cross	R/C		No sign	0%	Yes	50%		40%
	Cross	Veterans	R		No		No			
Veterans	Washington	Hadassah	R/C		Yes	75%	No	50%		
Washington	Elmwood	Shirley	R/C		No		No			
Shirley	Washington	Tewksbury	C		Yes	75%	Yes	90%	75%	95%
	Tewksbury	Terrace 1	R/C		No		Yes	90%		95%
	Terrace 1	Terrace 2	R/C		No		Yes	0%		50%
	Terrace 2	Yrrll Bch	R		No		No			
	Yrrll Bch	Petrel	R		Yes	10%	No			10%
	Petrel	Bayview	R		Yes	50%	No			45%
	Bayview	Tafts	R		No		Yes	50%		50%
Tewksbury	Winthrop Shore	Shirley	R		No		Yes	90%		95%
Tafts	Shirley	Elliot	R		No		Yes	80%		25%
	Elliot	Sea Wall	R		No		Yes	20%		0%
	Sea Wall	Deer Island	R		No		No			

TABLE 3.6-3 (cont'd)
CURBSIDE PARKING PRACTICE

Street	Cross Street One	Cross Street Two	Area Type	Location	Side A Parking Yes/No	% Prkng	Side B Parking Yes/No	& Prkng	Side A & Prkng	Side B & Prkng
Winthrop Shore	Beacon	Veterans	R		No		Yes	30%		15%
	Veterans	Grovers	R		No		Yes	10%		15%
Winthrop Pkwy	Upland	Winthrop Ave	R	Revere	No		No			
Winthrop Ave	Winthrop Pkwy	Sumner	R		Yes	0%	Yes	0%		
	Sumner	Crescent	C/R		Yes	2%	Yes	2%		
	Crescent	Bennington	C/R		Yes	95%	Yes	95%	95%	95%
	Bennington	Revere Bch Pkwy	C		No		No			
Revere Bch	Winthrop Ave	Route 16	C		No		No			
	Winthrop Ave	Route 16	R		No		No			
Revere Bch	Route 16	Broadway Off Ramp	C		No		No			
	Brdway Off Ramp	Brodway	R		No		No			
Broadway	Brdwy Off Ramp	Rte 16 E On Ramp		Chelsea	No		No			
	Rte 16 On Ramp	Eastern Ave	C		Yes	40%	Yes	40%	98%	98%
Eastern Ave	Broadway	Louis	C/R		Yes	85%	Yes	85%	95%	95%
	Louis	Gulf Sign	C/R		No		No			
	Gulf Sign	Central	I		No		No			
Marginal	Central	Willow	I		Roadway Under Construction					
Shelby	Lexington	Saratoga	C/R	E. Boston	Yes	95%	Yes	95%	100%	100%
Saratoga	Shelby	Neptune	C/R		Yes	100%	Yes	100%	100%	100%
Neptune	Saratoga	Bennington	C		Yes	95%	Yes	95%	100%	100%
	Bennington	Frankfurt	R		No		Yes	50%		0%

TABLE 3.6-3 (cont'd)
CURBSIDE PARKING PRACTICE

Street	Cross Street One	Cross Street Two	Area Type	Location	Side A Parking Yes/No	% Prkng	Side B Parking Yes/No	& Prkng	Side A & Prkng	Side B & Prkng
Bennington	Neptune	Trident	C/R		Yes	80%	Yes	80%	80%	80%
K Street	E 1st	Broadway	R	S. Boston	Yes	85%	Yes	85%	100%	100%
E. Broadway	K St.	L St.	C		Yes	95%	Yes	95%	90%	90%
	L St.	Farragut	R		Yes	90%	Yes	90%	90%	90%
	Farragut	WM J Day			Yes	90%	Yes	90%	90%	90%
WM J Day	Broadway	Ft Independence	Ocean		No		Yes	30%		90%

Source: PEER Consultants, P.C., 1987, 1988; See Appendix A.

3.6.1 POTABLE WATER, NATURAL GAS AND PERMANENT POWER - NORTHERN ROUTES

Route N-1

A description of the routes can be found in Section 2.4. Eastern Avenue, where the route begins, has a recorded peak hour volume of 602 vehicles. Its width ranges from approximately 42 feet to 53 feet. There is curbside parking between Louis Street and Broadway which was observed to be between 85 and 95 percent in use. There is no curbside parking south of Louis Street.

Broadway has a recorded peak hour volume of 1228 vehicles and is between approximately 42 and 48 feet wide. There is no curbside parking between the off ramp and the Route 16 E on-ramp, however, there is parking on both sides of the street from the Route 16 on-ramp to Easter Avenue. Parking use was observed to be between 40 and 98 percent.

Revere Beach Parkway is a divided six lane roadway which has a total recorded peak hour volume of 4500 vehicles. The east-bound side of the highway has a width of approximately 36 feet. There is no curbside parking allowed along this roadway.

Winthrop Avenue has a recorded peak hour volume of 1300 vehicles west of Bennington Street, 414 vehicles west of Winthrop Parkway and 1426 vehicles south of Winthrop Parkway. The roadway width varies from approximately 31 to 33 feet. Curbside parking is allowed along most of the route and observed use ranged from 0 to 95 percent.

Winthrop Parkway has a recorded peak hour traffic volume of 1426 vehicles. The roadway is approximately 36 feet wide and there is no curbside parking.

Revere Street, north of Crest Avenue, has a recorded peak hour volume of 1280 vehicles. Roadway width is approximately 35.5 feet. There is curbside parking along Revere Street and observed usage ranged from 5 to 60 percent.

Crest Avenue has a recorded peak hour volume of 644 vehicles. The roadway is approximately 31 feet wide. There is parking along the north side of the street and observed usage was 80 percent.

Winthrop Shore Drive has a recorded peak hour traffic volume of approximately 678 vehicles. The roadway width is between 35 and 36 feet. There is curbside parking along the east side of the street and observed usage ranged from 10 to 30 percent. Usage in the summer months probably increases to almost 100 percent.

Route N-1A

Route N-1A is identical to Route N-1 with the exception of Crest Avenue. Route N-1A avoids Crest Avenue and continues along Revere Street to Locust Street. Locust Street is a quiet residential street and no vehicle counts were available. Curbside parking was observed along

both sides of the street with 40 to 50 percent usage.

Route N-1B

Route N-1B is identical to Route N-1 as far as Crest Avenue. From here, the route continues down Revere Street to Shirley Street. Shirley Street has a recorded peak hour traffic volume of 455 vehicles. The roadway is approximately 26 feet wide. There is curbside parking allowed between Revere Street and Cross Street, and usage was observed to be about 50 percent.

Veterans Road has a recorded peak hour traffic volume of 297 vehicles. The roadway is approximately 33 feet wide. Curbside parking is allowed along one side of the street, and observed usage was about 75 percent.

Route N-1B briefly follows Washington Street to connect with Shirley Street. Washington Street, east of Veterans Road, has a recorded peak hour traffic volume of 702 vehicles. Washington Street is approximately 25 feet wide and there is no curbside parking allowed between Veterans Road and Shirley Street.

Shirley Street, south of Washington Street, has a recorded peak hour traffic volume of 579 vehicles. Roadway width varies from 25.5 feet to 41 feet. Curbside parking is allowed on both sides of the street between Washington Street and Tewksbury Street, and on one side almost to Yirrell Beach. Observed usage ranged from 0 to 95 percent.

Tafts Avenue has a recorded peak hour traffic volume of 286 vehicles. The roadway width is approximately 21 feet wide. Curbside parking is allowed on one side of the street up to the seawall. Observed parking usage ranged from 0 to 80 percent.

Route N-1C

Route N-1C has the same roadway characteristics as Route N-1. It then follows Tewksbury Street to connect to Shirley Street. Curbside parking is allowed along one side, and observed usage was between 90 and 95 percent.

The remainder of the route has the same characteristics as Route N-1B from Shirley Street to Deer Island.

Route N-1D

Route N-1D has the same roadway characteristics as Route N-1A. At the end of Yirrell Beach, the route follows Adams Street to connect with Tafts Avenue. From here, it has the same roadway characteristics as Route N-1B to Deer Island.

3.6.2 PERMANENT POWER - NORTHERN ROUTE

Route N-2

A description of Route N-2 can be found in Section 2.4. The route begins at the Chelsea Substation and travels cross country to Eastern Avenue. Eastern Avenue, north of Marginal Street, has a recorded peak hour traffic volume of 1,031 vehicles. The roadway is over 51 feet wide and no curbside parking is allowed along this section of the road.

Marginal Street, west of Eastern Avenue, has a recorded peak hour traffic volume of 325 vehicles. The roadway is approximately 38 feet wide. The roadway is currently under construction so no curbside parking was observed.

Condor and Shelby Streets in East Boston are neighborhood roadways which generally serve residents. No peak hour traffic volumes have been recorded. Shelby Street is approximately 34 feet wide and parking is allowed on both sides of the street. Observed usage ranged from 95 to 100 percent.

Neptune Street has a recorded peak hour traffic volume of 950 vehicles east of Saratoga Street. Roadway widths vary from 24 feet to 74 feet. Curbside parking is allowed, and observed usage ranged from 50 to 100 percent.

Bennington Street, north of Neptune Street, has a recorded peak hour traffic volume of 1,325 vehicles. Bennington Street is approximately 57 feet wide. Curbside parking is allowed and observed usage was about 80 percent.

3.6.3 INTERIM AND PERMANENT POWER - SOUTHERN ROUTES

Route S-1

Route S-1 does not affect any roadways.

Route S-2

Route S-2 begins at the K-Street Substation in South Boston. A description of the route can be found in Section 2.4 of this report.

K Street, north of Broadway, has a recorded peak hour traffic volume of 200 vehicles. The roadway is approximately 34 feet wide. Curbside parking is allowed on both sides of the street, and observed usage ranged from 85 to 100 percent.

Broadway, east of K Street, has a recorded peak hour traffic volume of 900 vehicles. Roadway width is approximately 60 feet. Curbside parking is allowed, and observed usage ranged from 90 to 95 percent.

William J. Day Boulevard between I and K Streets has a peak hour traffic volume of 1600 vehicles. Curbside parking is allowed and observed usage ranged from 30 to 90 percent.

3.6.4 MARINE TRAFFIC

Submarine construction could effect marine traffic traveling in and out of Boston Harbor. Data were collected on the movement of container vessels, vessels using Massachusetts Port Authority facilities, local cruises and ferry vessels, and a variety of other vessels using Port of Boston Facilities. This information is summarized in Tables 3.6.4-1, 3.6.4-2 and 3.6.4-3.

3.7 NOISE

Construction of the requisite off-island utility supplies to Deer Island will temporarily affect residential and commercial areas for each of the alternative routes being considered. Noise impacts associated with the off-island utility supplies are limited to noise produced during construction of each utility supply route; the transmission of electrical power, gas and potable water during facility operation will have no impact on ambient noise levels along the utility routes during operation of the Deer Island facilities.

Depending on the alternative utility route being considered, construction activities will be required in areas of the Towns of Winthrop, Chelsea, and Revere; the City of Boston; and in submarine cable crossings of Boston Harbor. The City of Boston provides a Noise Code which is applicable to these temporary construction activities. The code specifies that "... it shall be unlawful to operate a construction device at any street excavation, grading or repair, utility street work installation or repair, which produces a noise level exceeding 86 dBA at a distance of fifteen meters (50 feet) from the device." In addition, construction is not permitted at night or on weekends unless the construction noise level at the residential property line does not exceed 50 dBA.

Assessment of the temporary construction noise impacts to the affected communities is based on applying the above noise code, as well as considering the probable ambient noise levels. For each alternative utility supply route, the affected communities are identified on Figures 2.4.2-1 through 2.4.2-5 and Figure 2.4.3-1 for the northern utility routes, and on Figures 2.4.4-1 and 2.4.4-2 for the two alternative southern utility routes.

Sound levels were measured at 18 locations throughout the Town of Winthrop on June 14, 1984 (Havens & Emerson, 1984). The daytime sound levels were determined to be generally in the 50 dBA to 58 dBA range, with only three locations higher and two locations lower than this range. Extensive sound level measurements were also taken in the Point Shirley area of Winthrop as part of the Secondary Treatment Facilities Planning during September 1 through 18, 1986. This second study, which is summarized in Section 5.2.7 of Volume III of the Final EIR/EID, indicated that the very quietest part of the daytime hours are approximately 45 dBA.

In addition to the Town of Winthrop, the alternative utility supply routes traverse a diverse

TABLE [illegible] 4-1

BOSTON HARBOR YEARLY VESSEL ARRIVALS 1972-1985

Historical Record of Trips and Drafts
of Vessels (Inbound Only) Using the Port of Boston
Number of Trips Per Year

Draft (Ft)	1985	1984	1983	1982	1981	1980	1979	1978	1977	1976	1975	1974	1973	1972	Avg
41	0									3	1	2	1	0	
40	3	4	3	1	2	5	20	30	19	12	15	15	18	16	
39	7	5	2		4	20	26	40	36	41	41	25	56	41	
38	24	23	16	18	17	25	56	29	36	58	31	45	32	39	
37	29	22	13	17	42	21	43	29	55	45	43	44	41	39	
36	36	61	35	33	46	49	57	59	67	49	60	46	55	47	
35	47	61	44	56	77	77	69	87	69	57	55	58	62	69	
34	30	31	67	66	62	59	100	81	78	55	64	52	57	57	
33	33	17	21	36	37	37	52	57	85	59	55	44	80	57	
32	17	22	33	36	29	24	39	37	72	70	73	73	88	85	
31	31	33	40	35	36	43	49	33	70	81	56	69	91	98	
30	59	62	58	66	72	39	43	48	49	46	51	77	65	55	
29	31	51	73	67	74	58	43	31	37	42	36	45	78	44	
28	47	45	48	71	74	76	67	56	73	50	52	55	60	62	
27	76	61	62	104	82	74	101	90	94	70	70	91	95	72	
26	66	49	61	75	81	79	99	105	101	104	84	98	96	103	
25	97	65	40	72	54	57	73	92	56	79	72	85	88	97	
24	55	48	80	75	69	76	70	80	54	95	95	80	76	95	
23	65	63	51	76	71	58	47	39	40	49	69	63	85	118	
22	75	91	80	47	46	30	40	40	44	48	58	75	78	118	
21	65	79	31	35	13	36	32	51	37	43	50	43	75	83	
20	56	64	71	56	34	36	44	38	25	45	44	49	82	66	
19	65	42	41	52	57	40	37	45	43	36	23	30	54	62	
18 & Less	5,885	5,034	4,936	5,050	7,592	7,157	8,248	12,679	17,916	15,000	12,048	12,725	10,710	11,543	
19 or Greater	1,014	999	970	1,094	1,079	1,019	1,207	1,197	1,240	1,237	1,198	1,264	1,513	1,523	1,182
TOTAL	6,899	6,033	5,906	6,144	8,671	8,176	9,455	13,876	19,156	16,237	13,246	13,989	12,223	13,066	
% 19 or Greater	14.7%	16.6%	16.4%	17.8%	12.4%	12.5%	12.8%	8.6%	6.5%	7.6%	9.0%	9.0%	12.4%	11.7%	12.0%

Source: USACOE 1986 and Previous Editions; USACOE, 1987

Reference: "Draft Supplemental Environmental Impact Statement - Boston Harbor Co

TABLE 3.6.4-2
MASSPORT PORT OF BOSTON ARRIVALS

Vessel Type	1987	1986
Tankers	315	374
Full Container Vessels	248	215
Container Feeder Barges	184	192
General Cargo Vessels	89	85
Dry Bulk	81	82
Passenger Vessels	23	19
Other	11	7
	951	974

Source: Massachusetts Port Authority, 1986, 1987.

TABLE 3.6.4-3
MONTHLY VESSEL ARRIVALS

		Coast Guard	
	Massport Arrival	Port of Boston Arrival	Anchorage Arrival
January	64	73	11
February	63	58	12
March	74	59	7
April	58	43	9
May	59	49	10
June	67	79	6
July	59	56	4
August	65	57	3
September	58	64	10
October	64	54	1
November	51	56	2
December	78	84	5
	760	732	80
Monthly Avg	63	61	7

Source: Massachusetts Port Authority, 1987 and U.S. Coast Guard, 1987, 1988.

area of urban industrial, commercial, and residential locations. A representative ambient sound level of 50 dBA has been assumed for these areas, based on the typical values of 50 dBA to 60 dBA reported by Beranek in 1971 for average residential areas.

Section 3.7 References

Beranek, L.L. (ed.) 1971. Noise and Vibration Control, McGraw-Hill Co.; p. 579.

Havens & Emerson. 1984. Memorandum to U.S. Environmental Protection Agency, Region 1, from Thibault/Bubly Associates.

3.8 MARINE RESOURCES

The description of the marine environment in the vicinity of the proposed utility routes is derived from a review of the literature and results of site reconnaissance visits made on April 26 and May 17, 1988. Results of the Spring 1988 sediment sampling program conducted to describe the chemical and physical characteristics along the proposed submarine cable routes, S-1, S-2 and N-2 are also included. Figure 3.8-1 presents the three alternative submarine cable routes on a National Oceanographic and Atmospheric Administration (NOAA) map of Boston Harbor.

3.8.1 POTABLE WATER, NATURAL GAS AND PERMANENT POWER - NORTHERN ROUTES

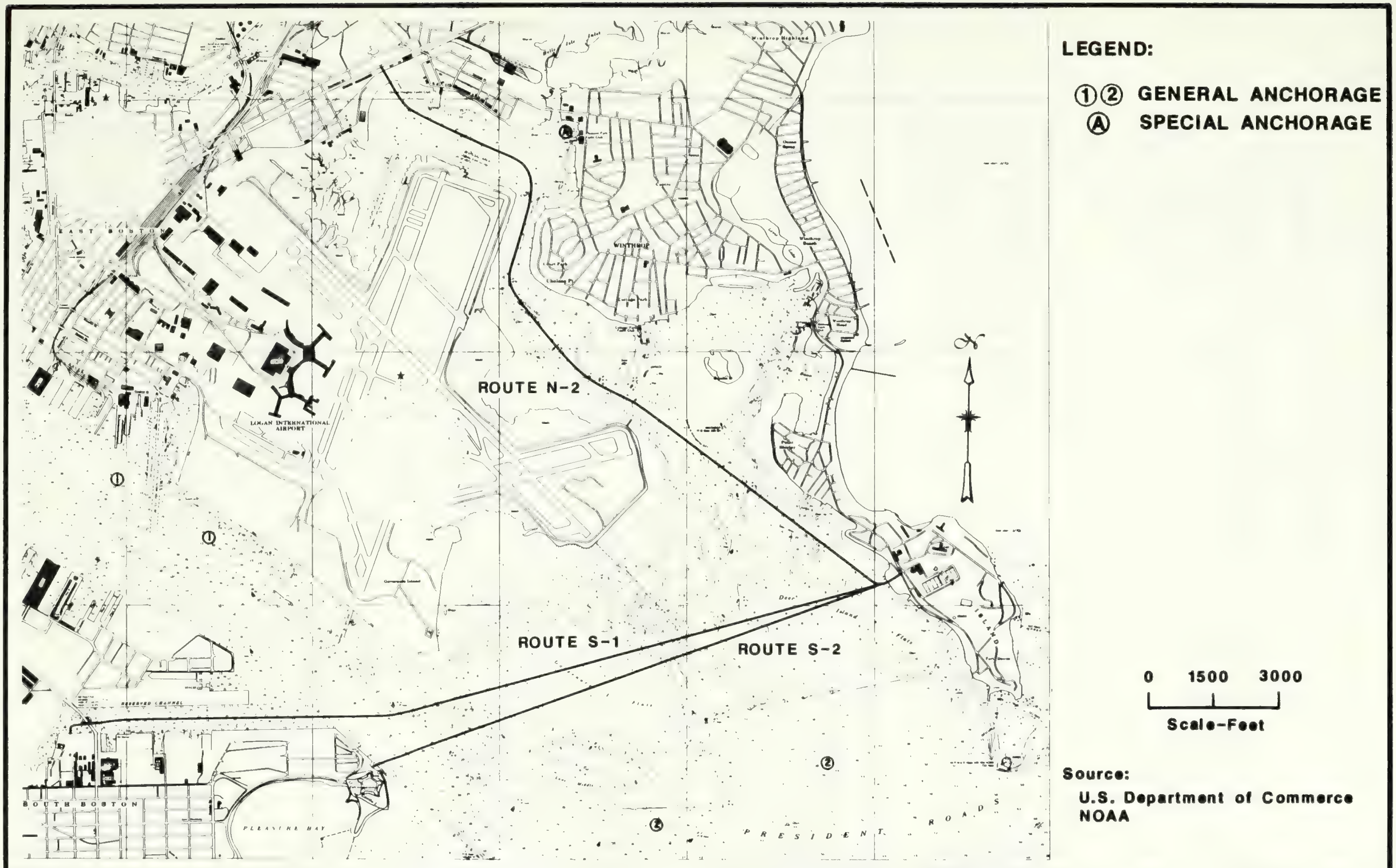
The proposed northern gas/water and permanent power route, Route N-1 and its various options N-1A, N-1B, N-1C, and N-1D are shown on Figures 2.4.2-1 through 2.4.2-5. A portion of N-1, N-1A, and N-1D follows the seawall along Yirrell Beach on the seaward side for approximately 3,125 to 6,250 ft.

Yirrell Beach is a broad, rather flat beach. The northern portion of the beach does not support any native biological communities (flora or fauna). The area above mean high water is primarily sand and cobble, littered with shell hash and some debris.

The southern half of Yirrell Beach widens to an upper and lower beach at the point where the seawall ends. The upper beach above mean high water is composed of cobble and boulder with scattered clumps of beach vegetation. The lower beach is an intertidal area composed of gravel, cobble and littered with debris (e.g. wood, tires, brick, glass, trash, seaweed, and general flotsam and jetsam).

Vegetation present in the upper beach includes grasses (Gramineae), goldenrod (Solidago spp.), ragweed (Ambrosia artemisiifolia), wormwood (Artemesia sp.), whorled loosestrife (Lysimachia quadrifolia), spurges (Euphorbia sp.), alsike clover (Trifolium hybridum), beach rose (Rosa rugosa) and a variety of unidentified forbs.

No state or federally listed threatened or endangered flora or fauna were observed.



MASSACHUSETTS WATER RESOURCES AUTHORITY

FIGURE 3.8-1
SUBMARINE CABLE ROUTES FOR OFF-ISLAND UTILITY SUPPLY

3.8.2 PERMANENT POWER - NORTHERN ROUTE

The proposed permanent power route alternative, Route N-2, for the 115 kV service to Deer Island from Boston Edison's (BECo) Chelsea Substation is shown on Figure 2.4.3-1. The submarine cable portion will begin at Orient Heights Beach and roughly follow the navigation channel through Winthrop Harbor south of Snake Island to Deer Island, a distance of approximately 3.5 miles.

Water Quality

Water quality sampling conducted by the Massachusetts Division of Water Pollution Control (DWPC) in 1985 and 1986 recorded no chronic violations of the SB water quality standards which are designated in that portion of Winthrop Harbor. Waters assigned the SB class are designated for the protection and propagation of fish and other aquatic life and wildlife, for primary and secondary contact recreation (e.g., swimming and boating), and for shellfish harvesting with depuration.

As shown on Table 3.8.2-1, water temperatures from June through October in 1985 and 1986 at Station 19 (Winthrop Harbor near Point Shirley) and Station 22 (Winthrop Bay off Constitution Beach) ranged from 14.0 to 22.2 °C. Salinity and dissolved oxygen concentrations ranged from 28.7 to 32.6 ppt and 4.5 (bottom) to 9.6 mg/l, respectively (DWPC 1986, 1987). pH values ranged from 6.9 to 8.2 and total coliform bacteria ranged from 5 to 1200 per 100 ml. For the most part, water quality values were well within SB class standards with occasional excursions outside the standards.

Concentrations of metals in the water column at stations in Winthrop Harbor are provided in Table 3.8.2-2. As shown on the table, concentrations of most metals are at or below detection limits used by DWPC. A comparison of water column concentrations with U.S. EPA Water Quality Criteria (1986 Gold Book) for the protection of saltwater aquatic life indicates that, for a number of metals (e.g., copper, silver and lead), the values obtained, although at or below detection limits, exceed EPA acute (CMC) and chronic (CCC) concentration limits. For example, copper concentrations in the water column were reported by DWPC (1986) to be 0.02 to 0.04 mg/l, an order of magnitude greater than the CMC value of 0.0029 mg/l. Overall, the detection limits used for metal analyses by DWPC do not allow a determination of the effects of water column metal concentrations on local biota.

Marine Biota

The description of the marine biota of Winthrop Harbor is derived primarily from the review of the literature on Boston Harbor and adjacent waters and studies conducted by U.S. Army Corps of Engineers (COE) in 1986 as part of their Harbor Improvement Project. Site visits to specific areas along the proposed route were also made on April 26, and May 18, 1988.

In general, the biota of Boston Harbor are composed of species common to the New England coastal zone. Both stenohaline (tolerant to a narrow range of salinities) and euryhaline

TABLE 3.8.2-1

SUMMARY OF WATER QUALITY DATA FOR WINTHROP HARBOR

Station	Temp. (oC)	Salinity (0/00)	D.O. (mg/l)	pH	Suspended Solids	TKN (mg/1)	NH4-N (mg/1)	Total Phosphorus (mg/1)	Total Coliform (per 100 ml
DWPC, 1986									
19	14.4-21.1	29.9-32.6	6.4-9.4	7.7-8.2	4.5-15	.38-1.5	.01-.20	.11-.15	20-380
22	14.9-22.2	28.7-32.4	5.2-8.8	6.9-8.2	4.0-33	.55-1.1	.01-.31	.09-.25	5-1200
DWPC, 1987									
22	14.0-20.5	29-30.2	4.5-9.6	7.7-8.0	9.0-36	1.2-2.1	.1-.2	.17-.34	10-1200
COE, 1987									
STA 14	15.8-16.3	31.5	9.0-10.6	7.8-7.9	---	---	---	---	---

Mass Water Quality Standards (SB)

D.O. 6.0 mg/l at 25 °C
pH 6.5-8.5
Total Coliform 700 per 100 ml

Source: DWPC, 1986, 1987; COE, 1987 (DRAFT)

TABLE 3.8.2-2

SUMMARY OF WATER CHEMISTRY DATA
FOR WINTHROP HARBOR

METAL (mg/1)	JUNE	JULY	AUGUST	OCTOBER	EPA WQC (mg/1)
Silver	.02-.03	<.02	<.02-.03	<.02	.0023*
Zinc	<.03	<.03	<.02-.10	<.06	.058
Arsenic	<.01	<.01	<.01	<.01	.036
Chromium	<.02-.04	<.02	<.02	<.02	.050
Lead	.20-.25	<.06	<.06	<.04	.0056
Copper	.04	.03-.04	<.02	<.02	.0029*
Nickel	.10-.13	<.03	<.03	<.05	.0083
Cadmium	.02-.05	<.02	<.01	<.02	.0093
Aluminum	<.10-.50	------	------	<.10	------
Thallium	------	<.06	<.06	------	2.1*
Selenium	------	<.005	<.01	------	.054

* Denotes CMC value; all others CCC

Source: DWPC, 1986
US EPA, 1986, 1987

(tolerant to a wide range of salinities) species are present. A brief description of the major components of the marine ecosystem is provided below.

Phytoplankton

Phytoplankton populations in Boston Harbor have been studied by a number of researchers over the past five decades. Most recently, studies have been conducted by Chesmore et al. (1971), New England Aquarium (1974), Metcalf and Eddy (1979, 1982), EG&G (1984) and Mackerel Cove Associates for the MWRA (1987). In general, the phytoplankton of the Harbor during the winter months is dominated by diatoms species such as Chaetoceros sp. and Nitzschia sp. and dinoflagellates such as Ceratium sp. Blooms occur in the spring and fall with increases in numerical abundance of diatoms correlating with high nutrient concentrations, particularly ammonia nitrogen, silica and phosphorus. A secondary phytoplankton "peak" often occurs in the summer, driven to a great extent by the availability of ammonia when all other nutrients (nitrate-nitrite, phosphorus) have been exhausted.

In July and August of 1987, Mackerel Cove Associates, as part of the Deer Island STFP, sampled the phytoplankton populations in the inner harbor, just west of Deer Island (Deer Island Flats) (Refer to Appendix Z to Volume V of the final Secondary Treatment Facilities Plan). Based on this sampling, the nannophytoplankton (the less than 10 micron fraction) were the most abundant component of the population with densities ranging from 46,662 to 126,654 cells/ml (Table 3.8.2-3). Flagellates and monads were the second most abundant group with densities ranging from 3,398 to 35,013 cells/ml. Diatoms were an order of magnitude less abundant than the nannophytoplankton with densities ranging from 255 to 6,279 cells/ml. Principal diatom species included Rhizosolenia fragilissima, Cerataulina pelagica, Leptocylindricus danicus, and L. minimus. Dinoflagellates were the least abundant species with densities ranging from 8-47 cells/ml.

The nannophytoplankton, in addition to being the most numerically abundant group, was also responsible for the majority (>70 percent) of chlorophyll production in the nearshore coastal waters.

Periodic minor blooms of euglenids which tend to proliferate in eutrophied waters were found at the inner Harbor station. Non-nuisance dinoflagellate species exhibited brief blooms but otherwise were numerically depauperate. Gonyaulax sp., the dinoflagellate responsible for paralytic shellfish poisoning (PSP), also known as "red tide". were absent from the inner harbor samples.

Blooms of Gonyaulax sp. historically have occurred in Boston Harbor in September of 1972 and in May and August of 1974 and sporadically since that time (SESD 1986). No single set of hydrographic conditions appear to coincide with red tide blooms. Reduced salinities, high temperatures and high concentrations of dissolved organic matter appear to precede or occur simultaneously with red tide blooms.

TABLE 3.8.2-3

RESULTS OF PHYTOPLANKTON SAMPLING
BOSTON HARBOR STATION N1, JULY AND AUGUST 1987

COMPONENT	NUMERICAL ABUNDANCE (cells/ml)			
	15 July	28 July	5 August	12 August
Nannophytoplankton	117,766	81,659	126,654	46,662
Diatoms	1,553	255	6,279	2,878
Flagellates + Monads	3,398	11,268	35,013	_____
Dinoflagellates	47	8	417	51
Microzooplankton				
Ciliates	6	6	11	4
Tintinnids	0	4	146	2

Source: Appendix Z to Volume V of the STFP, 1988

Benthic Macrofauna

Benthic grab samples were collected from four stations in Winthrop Harbor north of Snake Island and west of Point Shirley in 1986 by COE (COE, 1987). Overall, oligochaetes, spionids (Streblospio benedicti) and amphipods (Ampelisca abdita) accounted for 77 percent of the total number of individuals.

Invertebrate densities ranged from 132.3 per 0.1 m^2 at Station 4 (west of Point Shirley) to 21.5 per 0.1 m^2 at Station 3. The number of species present ranged from a low of 8 at Station 3, to 21 at Station 4 (Table 3.8.2-4). The Shannon-Weaver diversity indices indicated that the distribution of individuals among species was heterogeneous at all stations.

Surveys conducted elsewhere in Boston Harbor in the late sixties and early seventies indicated that bottom conditions throughout most of the harbor were generally degraded resulting in depressed numbers of macroinvertebrate species. Studies conducted by the New England Aquarium indicated dominance by the pollutant-tolerant polychaete, Polydora ligni throughout much of the Harbor, except in the inner reaches of Winthrop Harbor where the polychaete Capitella capitata dominated (NEA, 1974).

More recent data collected by Metcalf and Eddy (1979, 1982), EG&G (1984) and MWRA (1987) provide relevant information on species composition, abundance and distribution of benthic invertebrates in Boston Harbor and Massachusetts Bay. For the most part, benthic macrofauna in the Harbor are dominated by three major groups: polychaetes, crustaceans and molluscs. At stations within the Boston Harbor system, tube-building spionid and capitellid polychaetes tend to be the dominant forms. Outside of Boston Harbor (in Broad Sound and Massachusetts Bay), infauna are more diverse and appear healthy and unstressed (pollutant-tolerant infauna, indicators of organic enrichment, were absent or present in low numbers) (Refer to Appendix T to Volume V of the STFP).

In addition to the infaunal species, a variety of other bottom-dwelling organisms are present in Winthrop Harbor. These include shellfish such as the soft-shell clam (Mya arenaria), the hard-shell clam (Mercenaria mercenaria), and the edible blue mussel (Mytilus edulis), as well as crustaceans such as the lobster (Homarus americanus), Jonah and rock crabs (Cancer irroratus and C. borealis), the green crab, (Carcinus maenas), and arthropods such as the horseshoe crab (Limulus polyphemus). Table 3.8.2-5 lists the species of benthic invertebrates present in Winthrop Harbor.

Fisheries Resources - Finfish

Winter flounder (Pseudopleuronectes americanus) is the most important finfish species in Boston Harbor and Winthrop Harbor. It is sought both commercially and recreationally. Winter flounder comprise the majority of the fish present in the northern part of the Harbor (west of Deer Island) because of the organically-rich sediments which support an abundance of bottom invertebrates important in the diet of flounder.

TABLE 3.8.2-4

DOMINANT INVERTEBRATES OF WINTHROP HARBOR

Organism	Station (% total avg. density) 1	2	3	4
Oligochaeta	53.3	25.2	39.5	21.0
Polychaeta				
Microphthalmus screl	4.1	2.8	0.0	8.5
Nereis virens	4.9	7.0	0.0	0.0
Clymenella torquata	0.0	0.0	0.0	6.4
Streblospio benedicti	28.7	23.1	47.7	46.7
Tharyx acutus	0.0	0.0	2.3	2.8
Gastropoda				
Nassarius trivittatus	0.0	0.0	0.0	2.1
Bivalvia				
Modiolus modiolus	0.0	0.0	2.3	0.2
Crustacea				
Amphipoda				
Ampelisea abdita	2.5	37.1	0.0	3.2
Decapoda				
Crangon septemspinosa	3.3	1.4	1.2	0.0
Others	3.3	3.5	7.0	9.1
Avg. Density (per 0.1 m^2)	30.5	35.8	21.5	132.3
Avg. Number Species (per 0.1 m^2)	5.0	4.8	3.0	10.0

Source: COE, 1987

TABLE 3.8.2-5

BENTHIC INVERTEBRATE SPECIES PRESENT IN WINTHROP HARBOR

Scientific Name

- Oligochaeta
- Polychaeta
  - *Clymenella torquata*
  - *Nereis virens*
  - *Microphthalmus screl*
  - *Streblospio benedicti*
  - *Tharyx acutus*
- Gastropoda
  - *Nassarius trivittatus*
- Bivalvia
  - *Modiolus demissus*
  - *Mytilus edulis*
  - *Gemma gemma*
  - *Tellina agilis*
  - *Mya arenaria*
- Crustacea
  - Amphipoda
  - *Ampelisca abdita*
  - *Gammarus mucronatus*
  - *Corophium* sp.
- Decapoda
  - *Crangon septemspinosa*
  - *Carcinus maenas*
  - *Homarus americanus*

Source: COE, 1987

Winter flounder utilize Boston Harbor for feeding, spawning and nursery purposes. Flounder spawn from January through May in shoal water (e.g., in bays, estuaries, mouths of rivers and backwater areas) on sandy bottoms. In Winthrop Harbor, flounder spawn from mid-February to April. They are opportunistic in their feeding regime, consuming invertebrates such as coelenterates, nemerteans, polychaetes, crustaceans, molluscs and ascidians (EPA, 1988).

A number of other finfish species also occur within Boston Harbor (Table 3.8.2-6) and include pollock, cunner, Atlantic tomcod, red hake, mackerel, smelt and bluefish. Species typically found in Winthrop Harbor include pollock, bluefish, and Atlantic cod (COE, 1987). Pollock are most abundant from spring through autumn. Young bluefish are likely to be present throughout part of the year.

Although some commercial fishing occurs in Boston Harbor (limited gill netting and purse seining), the majority of commercial finfishing occurs outside the harbor in Broad Sound and Massachusetts Bay. This is due to state-imposed regulatory fishing boundaries which prohibit otter and beam trawling in the harbor year-round and conflicts with fixed gear (e.g., lobster pots). A large recreational sportfishery does occur within Boston Harbor.

Because flounder are demersal (bottom-dwellers), they have the ability to bioaccumulate toxic substances such as PCBs, PAHs and metals contained in the sediments. Winter flounder collected from Boston Harbor have been shown to contain significantly higher concentrations of PCBs than flounder collected from offshore coastal areas. PCB concentrations in Harbor flounder ranged from 0.24 to 0.67 ppm compared to coastal flounder with concentrations ranging from 0.05 to 0.17 ppm (Schwartz 1987).

Fisheries Resources - Lobster

Lobster (Homarus americanus) are by far the most economically important marine resource in Boston Harbor. The inshore fishery is seasonal with lobstermen heavily fishing Boston Harbor areas from late spring to late summer. The fishery moves offshore (to Mass Bay) in the fall when lobster migrate to deeper water, and to take advantage of the offshore stocks. Winthrop Harbor is not considered a significant source of lobsters.

Boston Harbor offers suitable habitat for lobster spawning, growth and development since they can make use of a variety of substrates (mud, sand, gravel, rock outcrops). Throughout much of the harbor, lobsters can be found in mud burrows. Because they are opportunistic in their feeding regime, feeding on bottom invertebrates, lobsters, like flounder, have the potential for bioaccumulating toxic substances such as PCBs, PAHs, and metals. In a recent study completed by the Massachusetts Division of Marine Fisheries, lobster collected from Boston Harbor and Salem Harbor had significantly higher PCB concentrations than coastal lobster, 1.17 ppm versus 0.57 ppm, respectively (Schwartz 1987).

Fisheries Resources - Shellfish

Shellfish, particularly the soft-shell clam (Mya arenaria) is an abundant resource in Boston

TABLE 3.8.2-6

PARTIAL LISTING OF FISH SPECIES OCCURRING IN BOSTON HARBOR

COMMON NAME	SCIENTIFIC NAME
Winter Flounder	Pseudopleuronectes americanus
Atlantic Tomcod	Microgadus tomcod
Atlantic silverside	Menidia menidia
Mummichog	Fundulus heteroclitus
Striped killifish	Fundulus majalis
Rainbow smelt	Osmerus mordax
Alewife	Alosa pseudoharengus
Blueback herring	Alosa aestivalis
Cunner	Tautogolabrus adspersus
Red Hake	Urophycis chuss
Pollock	Pollachius virens
Fourspine stickleback	Apeltes quadracus
Threespine stickleback	Gasterosteus aculeatus
Ninespine stickleback	Pungitius pungitius
Windowpane flounder	Scopthalamus aquosus
Striped bass	Morone saxatilis
White perch	Morone americanus
American eel	Anquilla rostrata
Silver hake	Merluccius bilinearis
Northern pipefish	Syngnathus fuscus
Lumpfish	Cyclopterus lumpus
American sand lance	Ammodytes americanus
Spiny dogfish	Squalus acanthias
Redfin pickerel	Esox americanus americanus
Grubby	Myxocephalus aeneus
Ocean pout	Macrozoarces americanus
Atlantic mackerel	Scomber scombrus
Smooth flounder	Liopsetta putnami
Yellow flounder	Limanda ferruginea
Bluefish	Pomatomus saltatrix

Source: USEPA, 1976; 1988

Harbor; however, almost half of the clam flats in the area are closed due to gross contamination. The other half of the soft-shell clam flats are open to Master Diggers only and the clams must be depurated at the Newburyport Plant. Soft-shell clams are currently harvested from the mud flats around Snake Island and off the northwesterly shore of Point Shirley.

Clam flats may be opened or closed in response to weather changes. Periodic monitoring by state biologists determines the level of contamination present in local shellfish. Within the Winthrop Harbor area, the flats along Orient Heights, and from Point Shirley north to Winthrop Head are all closed (Figure 3.8.2-1) (EPA 1988).

Other shellfish species present in Boston Harbor include the blue mussel (Mytilus edulis), the ribbed mussel (Modiolus demissus) and the duck clam (Macoma balthica). Mussels, though generally abundant within the intertidal areas in the Harbor, are not commercially sought after to any great extent.

Marine Vegetation

Metcalf and Eddy (1984) indicated that 56 species of macroalgae are known from the Boston Harbor area. Dominant species include the rockweeds (Fucus spp.), knotted wrack (Ascophyllum nodosum), kelps (Laminaria spp.), Irish moss (Chondrus crispus), and green algae such as sea lettuce (Ulva lactuca), Enteromorpha spp. and Monostroma spp. (Refer to Appendix L to Volume V of the STFP). Historically, there have been problems of excessive growth of the green algae, Ulva, in Winthrop Harbor due to organic enrichment (NEA 1974).

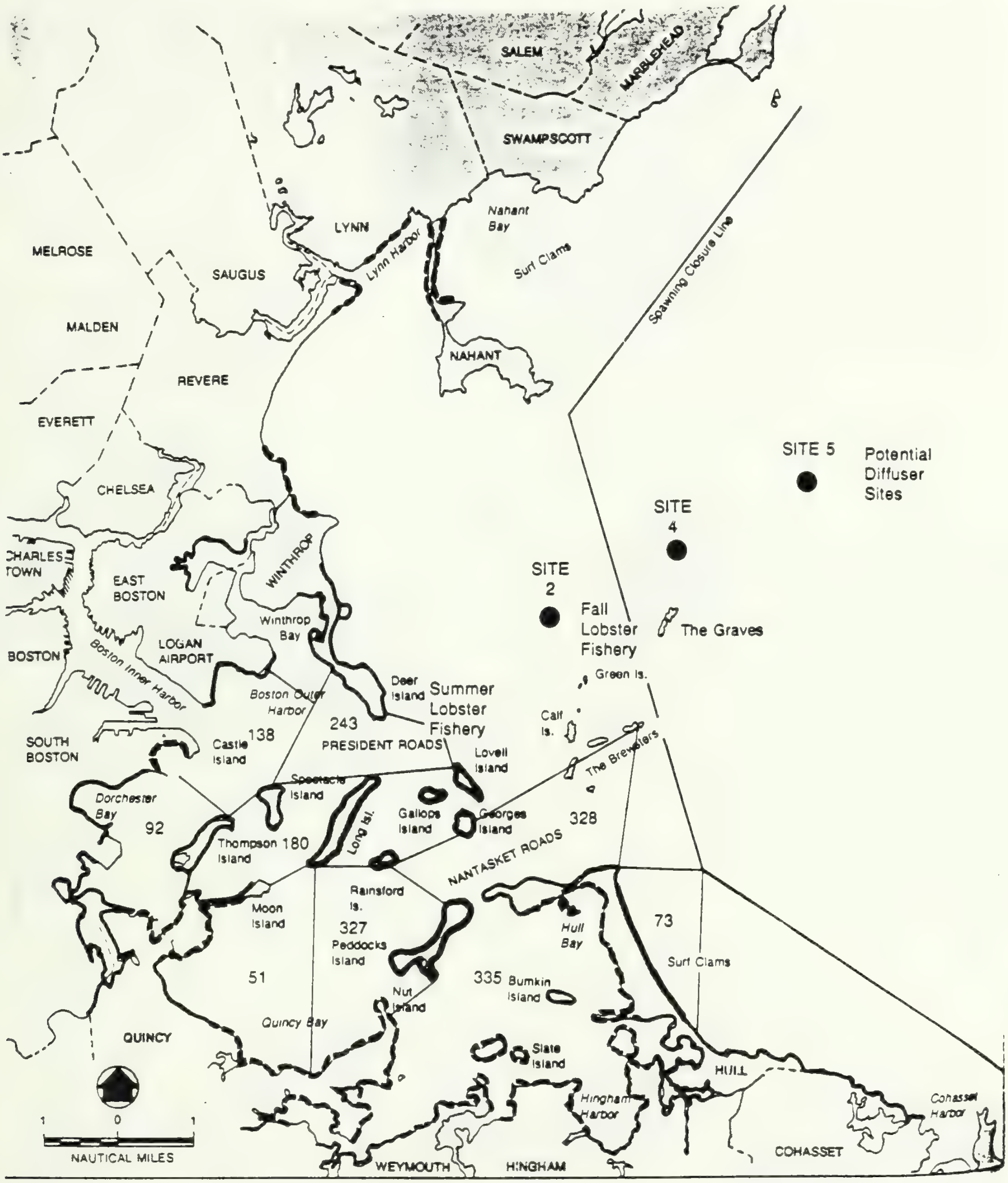
Based on the resource mapping effort conducted by Battelle Ocean Sciences for the MWRA Deer Island STFP Project, several areas of imporant marine vegetation are present within Winthrop Harbor. Tidal wetlands (Spartina alterniflora and S. patens) are present along Snake Island, in and along the east side of Logan Airport and the northern part of Winthrop Bay (Figure 3.8.2-2). An area of significant submerged vegetation has also been identified in the area of the Deer Island Flats.

Results of the Site Visit

A site visit was made to Orient Heights Beach on April 26, 1988 during mid-tide to locate and identify significant maine resources present in the area likely to be impacted by the submarine cable.

Orient Heights Beach consists of a broad expanse of sand and silty sand. The upper part of the beach (above mean high water) was medium to coarse sand, while the lower part of the beach (MSL and MLW) was sand and silty sand. At the northern end of the beach near some pilings, and below the mean high water level, was a small rock outcrop which appeared to support a small stand of saltwater cord grass (Spartine alternflora). This small patch was the only wetland-type vegetation observed on the beach.

The beach was littered with shell hash, mostly that of soft-shell clam, blue mussel and ribbed



LEGEND

98 Approximate Number of Lobster Buoys 7/27/79

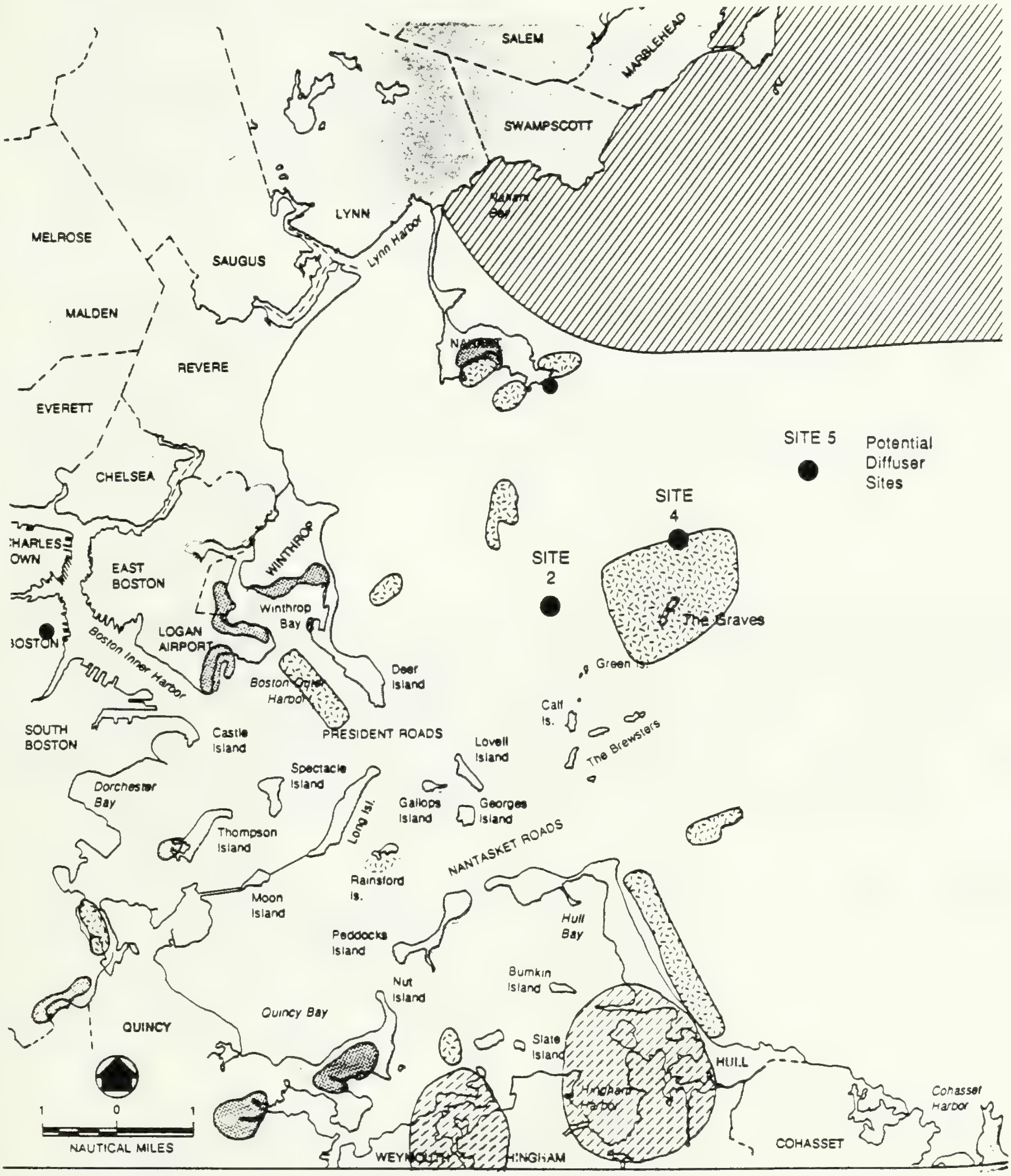
Shellfish Beds Closed to All Diggers (Closure Varies w/Conditions)

Shellfish Beds Restricted to Master Diggers

Sources: Metcalf & Eddy, 1984
MWRA Vol. V App. L, 1987
MWRA Vol. V App. B, 1987
MDMF, 1988

MASSACHUSETTS WATER RESOURCES AUTHORITY

FIGURE 3.8.2-1
COMMERCIAL FISHING RESOURCES



LEGEND

- Saltmarsh
- Significant Identified areas of Submerged Vegetation
- Areas of Critical Environmental Concern
- South Essex Ocean Sanctuary
- Marine Research Facilities

Sources: MWRA Vol. V, APP.L, 1987
BARR, 1987

(Shellfish Beds Shown on Figure D.3.c)
(Bathing Beaches Shown on Figure D.3.d.)

MASSACHUSETTS WATER RESOURCES AUTHORITY	FIGURE 3.8.2-2 SENSITIVE MARINE RESOURCES

mussel and periwinkles (Littorina sp.). There was also a considerable amount of marine algae littering the beach. The seaweed was dominated by green algae such as sea lettuce (Ulva lactuca), and Enteromorpha spp. Some remnant brown algae (Fucus sp.) was also present but was not abundant. There was a slight odor of sewage from the beach, supporting the presence of green algae, often indicative of organic enrichment.

3.8.3 INTERIM AND PERMANENT POWER - SOUTHERN ROUTES

The proposed southern interim and permanent route (S-1) and its alternate (S-2) for the 115kV service to Deer Island are shown on Figures 2.4.4-1 and 2.4.4-2. The submarine cable portion of the permanent route (S-1) which originates from the K Street Substation near New Boston Station would begin at the Reserved Channel and extend east of Deer Island, a distance of approximately 3.5 miles. The submarine portion of the alternate southern route (S-2) would originate at Fort Independence (Castle Island) near the SeaLand Terminal and extend east 2.5 miles to Deer Island.

Water Quality

Water quality sampling was conducted by the DWPC in 1986 and 1987 in the main channel of Boston Inner Harbor near the mouth of the Reserved Channel. The Reserved Channel area is designated as class SC. Waters assigned to this class are designated for the protection and propagation of fish, other aquatic life and wildlife, and for secondary contact recreation. The remainder of the proposed submarine cable route is designated as SB class waters. Waters in the SB class are designated for the uses of protection and propagation of fish, other aquatic life and wildlife, for primary and secondary contact recreation, and for shellfish harvesting with depuration.

As shown on Table 3.8.3-1, water temperatures from June through October in 1985 and 1986 at Station 6 (mouth of the Reserved Channel) ranged from 12.0 to 21.7 $^{\circ}$C. Salinity and dissolved oxygen concentrations ranged from 27 to 34.4 ppt and 3.6 (surface) to 8.5 mg/1, respectively (DWPC 1986, 1987). pH values ranged from 7.5 to 8.0 and total coliform bacteria ranged from 120 to 6000 per 100 ml. For the most part, water quality values were well within SC class standards with occasional excursions outside the standards (e.g., coliform bacteria and D.O.).

Water column concentrations of metals from stations in the Reserved Channel are provided in Table 3.8.3-2. As shown on the table, concentrations of most metals are at or below detection limits used by DWPC. A comparison of water column concentrations with U.S. EPA Water Quality Criteria (1986 Gold Book) for the protection of saltwater aquatic life indicates that, for a number of metals (e.g., cooper, silver and lead), the values obtained, although at or below detection limits, exceed EPA acute (CMC) and chronic (CCC) concentrations. For example, copper concentrations in the water column were reported by DWPC (1986) to be 0.02 to 0.05 mg/1, an order of magnitude greater than the CMC value of 0.0029 mg/1. In addition, several metals have detection limits above the EPA Criteria; thus, no definitive statements can be made about these metals with regard to exceedances of the Criteria and potential effects on local biota.
Overall, the method detection limits used for metals analyses by DWPC do not allow a

TABLE 3.8.3-1

SUMMARY OF WATER QUALITY DATA FOR THE RESERVED CHANNEL

Station	Temp. (oC)	Salinity (0/00)	D.O. (mg/l)	pH	Suspended Solids	TKN (mg/1)	NH4-N (mg/1)	Total Phosphorus (mg/1)	Total Coliform (per 100 ml
DWPC, 1986									
6	13.9-21.7	28.8-32.8	5.6-7.9	7.5-7.8	5.5-17	.44-1.6	.04-.62	.05-.16	200-6,000
DWPC, 1987									
6	12.0-20.0	27.0-34.4	3.6-8.5	7.9-8.0	2.0-26	.79-2.4	.07-.22	.13-.22	120-5,000
1	13.5-19.0	25.0-27.3	7.6	----	----	----	----	----	----
COE. 1987									
5	13.9-17.2	24.0-27.0	9.0	----	----	----	----	----	----

Mass. Water Quality Standards (SC)

D.O. = 6.0 mg/l at 25° C
pH = 6.5 - 8.5
Fecal Coliform = 1000 MPN per 100 ml

Source: DWPC 1986, 1987; Hubbard 1987

TABLE 3.8.3-2

SUMMARY OF WATER CHEMISTRY DATA FOR THE RESERVED CHANNEL, 1985

PARAMETER ER	JUNE	JULY	AUGUST	OCTOB
		mg/l		
Silver	.02-.03	<.02	<.02-.03	<.02
Zinc	.01-.03	<.03	<.03	<.03
Arsenic	.01	<.01	<.01	<.01
Chromium	.03-.04	<.02	<.02	<.02
Lead	.21-.23	<.06	<.06	<.04
Copper	.04	.04-.05	<.02	<.02
Nickel	.12-.15	<.03	<.03	<.05
Cadmium	.02-.04	<.02	<.01	<.02
Aluminum	.50	---	---	<.1

Source: DWPC, 1986

determination of the effects of water column metal concentrations on local biota.

Marine Biota

The description of the marine resources of Boston Harbor in the vicinity of the proposed power routes S-1 and S-2 is derived from a review of the literature on Boston Harbor and adjacent waters. Studies on the marine resources of Dorchester Bay (i.e., the northern part, which includes Pleasure Bay) and data from the 301 (h) Waiver Application prepared by Metcalf and Eddy (1979) for the MDC and the draft supplemental EIS (EPA 1988) serve as the prime data sources for the area. A site visit was also made on April 26, 1988 to the area likely to be affected by the proposed power route, adjacent to Fort Independence (Castle Island) on April 26, 1988.

For the most part, the marine resources of the Harbor in this region are similar to those described for the northern route (MDC 1979). Plankton, fish, shellfish and marine vegetational communities are expected to be similar in species composition and abundance. Some differences, however, are expected, particularly in benthic species composition and abundance beween the northern waters and southern waters of Boston Harbor due primarily to nutrient enrichment from the Deer Island Wastewater Tretment Plant (EPA 1988).

The southern portion of the harbor (near Nut Island) is generally characterized by moderately dense communities with a high number of taxa, high eveness and diversity with relatively high numbers of pollution-sensitive amphipods (EPA, 1988). The northern part of the Harbor, in the vicinity of Deer Island and west of the Island, is characterized by a benthic community that appears to be more impacted by pollution, exhibiting indices indicative of stressed conditions (e.g., low species diversity, dominance by a few opportunistic species and few amphipods (EPA, 1988). It is, therefore, expected that benthic organisms along the proposed southern routes (S-1 and S-2) are somewhat transitional between the two extremes. Moderate species diversity, eveness and richness are anticipated.

The U.S. Army Corps of Engineers, New England Division (NED) conducted biological sampling in the Reserved Channel in July and November 1986 to characterize the benthic habitat in areas proposed for improvement dredging (Hubbard 1987). The substate at Station 1, located east of the Summer Street Bridge was azoic. The absence of macrobenthic organisms was attributed to sulphide comporinds present in the sediments, poor circulation and/or oil contamination. The July benthic population at Station 2, located at the turning basin at the mouth of the channel, was dominated by polychaetes (Capitella capitata - 85.5%; Eteone Flave - 5.3%; Anatides mucosa - 1.6%; Spio armata - 1.6%; Strehlospio benedicti - 1.6%), oligochaetes (1.6%) and Tubificaides spp. (1.6%). The November benthic population was dominated by the spionid polychaete Polydora ligni (60.0%). Other species included the bivalve Modevhus modiolus (20.0%) and the ampmped chistacian Ampelisca abdeta (20.0%) (Table 3.8-9).

In summary, the benthic assemblages in the Reserved Channel were dominated by polychaetes. Capitella Capitata (700./m^2) in July and the spionid polychaete Polydora ligni (18.75/m^2) in

November at Station 2 (near the Main Ship Channel). The inner portion of the Reserved Channel was azoic.

Biological sampling was also conducted in the main ship channel across from the Reserved Channel by COE in July and November 1986 (Table 3.8.3-3). The July benthic population was composed of 6125-0 individuals per m^2, representing 41 species. The top five dominant species were oligochaeta Tubificoides sp. (18.8%), the polychaete Polydora aggregata (11.0%), Spio armata (9.5%), Polydora ligni (8.6%) and Nephyts caeca (4.8%). The November benthic population was composed of 1,931.4 individuals/m^2, representing 16 species. Dominant species included the spionid polychaete, Streblospio benedict (35.6%), the oligochaete tubificades spp. (28,75%), the Polychaete Polydora ligni (21.7%), Tharyz acutus (5.2%) and Spio sp. (3.2%).

Finfish sampling by gill net was conducted at Station 5 in July and November, 1986 by COE (Table 3.8.3-4). Winter flounder was the most abundant species collected. Other species caught in the dimersal and pelagic gill nets included rainbow smelt, windowpane flounder, Atlantic tomcord, alewife, blueback herring, menhaden, macherel, longhorn sculpin, American lobster, Jonah crab and green crab (Hubbard 1987).

Results of the Site Visit

The waterfront adjacent to the SeaLand Terminal at Castle Island (Fort Independence) was visited on April 26, 1988. The area between the SeaLand Terminal and the John J. McCorckle Fishing Pier consisted of a small rocky embayment. Recent restoration of the area along the existing seawall had been conducted by MDC's MetroParks Department and consisted of tree and grass plantings to create a scenic harbor view. Large granite and concrete blocks had been deposited down by the waterline. The intertidal zone supported heavy growth of rockweed (Fucus spp.), and some green algae (Enteromorpha spp.) and blue-green algae. Barnacles (Balanus sp.) and perwinkles were also present on the rocks and pilings.

The beach within this small embayment was covered by heavy shell hash, mostly consisting of blue mussel. There was also a considerable amount of flotsam and jetsam (e.g., baulks of timber, glass, plastic, bricks and debris).

3.8.4 SEDIMENT CHEMISTRY

Historic Sediment Data

Historic data on concentrations of metals, PAHs and PCBs in sediments along the proposed submarine power routes (Figure 3.8.4-1) were reviewed to evaluate the potential for adverse impact to local marine biota as a result of resuspension of contaminants within the sediments from cable embedding operations. Additional site-specific sediment data have been obtained from sampling locations along the proposed power supply routes, which were collected in mid-May 1988. These data are included in Appendix B, are and described herein.

TABLE 3.8.3-3

SUMMARY OF BENTHIC SAMPLING
RESERVED CHANNEL AND
MAIN SHIP CHANNEL
JULY AND NOVEMBER 1986

TAXA	JULY		NOVEMBER	
	No. Per M^2	Percent of Total	No. Per M^2	Percent of Total
STATION 1	0	----	0	----
STATION 2	(Reserved Channel)			
POLYCHAETA				
Anaitides mucosa	12.50	1.6	----	----
Eteone flava	43.75	5.3	----	----
Microphthalamus aberrans	6.25	0.8	----	----
Polydora aggregata	6.25	0.8	----	----
Polydora ligni	----	----	18.75	60.0
Spio armata	12.50	1.6	----	----
Streblo spio benedicti	12.50	1.6	----	----
Capitella capitata	700.00	85.0	----	----
OLIGOCHAETA				
Oligochaeta	12.50	1.6	----	----
Tubiticoides spp.	12.50	1.6	----	----
BIVALVIA				
Modiolus modiolus	----	----	6.25	20.0
AMPHIPODA				
Ampelisca abdita	----	----	6.25	20.0
Total	818.80	100.40	31.25	100.0

TABLE 3.8.3-3 (cont'd)

TAXA	JULY		NOVEMBER	
	No. Per M^2	Percent of Total	No. Per M^2	Percent of Total
STATION 5	(Main Channel)			
NEMERTINEA				
Nemertinea	12.50	0.2	----	----
POLYCHAETA				
Harmothoe imbricata	75.00	1.2	----	----
Pholoe minuta	256.25	4.2	----	----
Anaitides mucosa	118.75	1.9	----	----
Eteone flava	275.00	4.5	12.5	0.6
Microphthalmus aberrans	287.50	4.7	----	----
Autolytus sp. (Polybostrichus)	6.25	0.1	----	----
Nereis virens	281.25	4.6	----	----
Nephtys caeca	293.75	4.8	6.25	0.3
Schistomeringos caeca	6.25	0.1	----	----
Polydora socialis	12.50	0.2	12.5(imm)	0.6
Polydora quadrilobata	68.75	1.1	----	----
Polydora ligni	525.00	8.6	418.75	21.7
Polydora aggregata	675.00	11.0	----	----
Prionospio (P.) steenstrupi	212.50	3.5	----	----
Spio filicornis	181.25	3.0	----	----
Spio cf. limicola	56.25	0.9	62.5(imm)	3.2
Spio armata	581.25	9.5	----	----
Streblospio benedicti	137.50	2.2	687.50	35.6
Trochochaeta multisetosa	31.25	0.5	----	----
Cirratulidae sp. (fragment)	25.00	0.4	----	----
Caulleriella sp.	250.00	4.1	----	----
Pherusa plumosa	31.25	0.5	----	----
Capitella capitata	100.00	1.6	----	----
Mediomastus californiensis	18.75	0.3	6.25	0.3
Pectinaria granulata	18.75	0.3	----	----
Ampharete arctica	6.25	0.1	----	----
Polycirrus sp.	6.25	0.1	----	----
Tharyx acutus	----	----	6.25	0.3
Autolytus sp.	----	----	6.25	0.3

TABLE 3.8.3-3 (cont'd)

TAXA	JULY		NOVEMBER	
	No. Per M^2	Percent of Total	No. Per M^2	Percent of Total
OLIGOCHAETA				
Oligochaeta	12.50	0.2	----	----
Tubificoides spp.	1150.00	18.8	550	28.5
GASTROPODA				
Nassarius trivittatus	56.25	0.9	6.25	0.3
BIVALVIA				
Modiolus sp. (juvenile)	125.00	2.0	6.25	0.3
Tellina sp. (juvenile)	18.75	0.3	----	----
Mya arenaria	6.25	0.1	25.0	1.3
Hiatella arctica	18.75	0.3	----	----
Bivalvia sp. (juvenile)	18.75	0.3	6.25	0.3
CUMACEA				
Diastylus sp.	----	----	12.5	0.6
CRUSTACEA				
Edotea triloba	18.75	0.3	----	----
Ampelisca abdita	87.50	1.4	12.5	0.6
Corophium sp. (juvenile)	12.50	0.2	----	----
Unciola irrorata	37.50	0.6	----	----
Photis pollex	12.50	0.2	----	----
Total	6125.00	99.8	1931.25	99.7

Source: Hubbard, 1987

TABLE 3.8.3-4

SUMMARY OF FINFISH SAMPLING
MAIN SHIP CHANNEL (STATIONS 3,4,5,6)
JULY AND NOVEMBER 1986

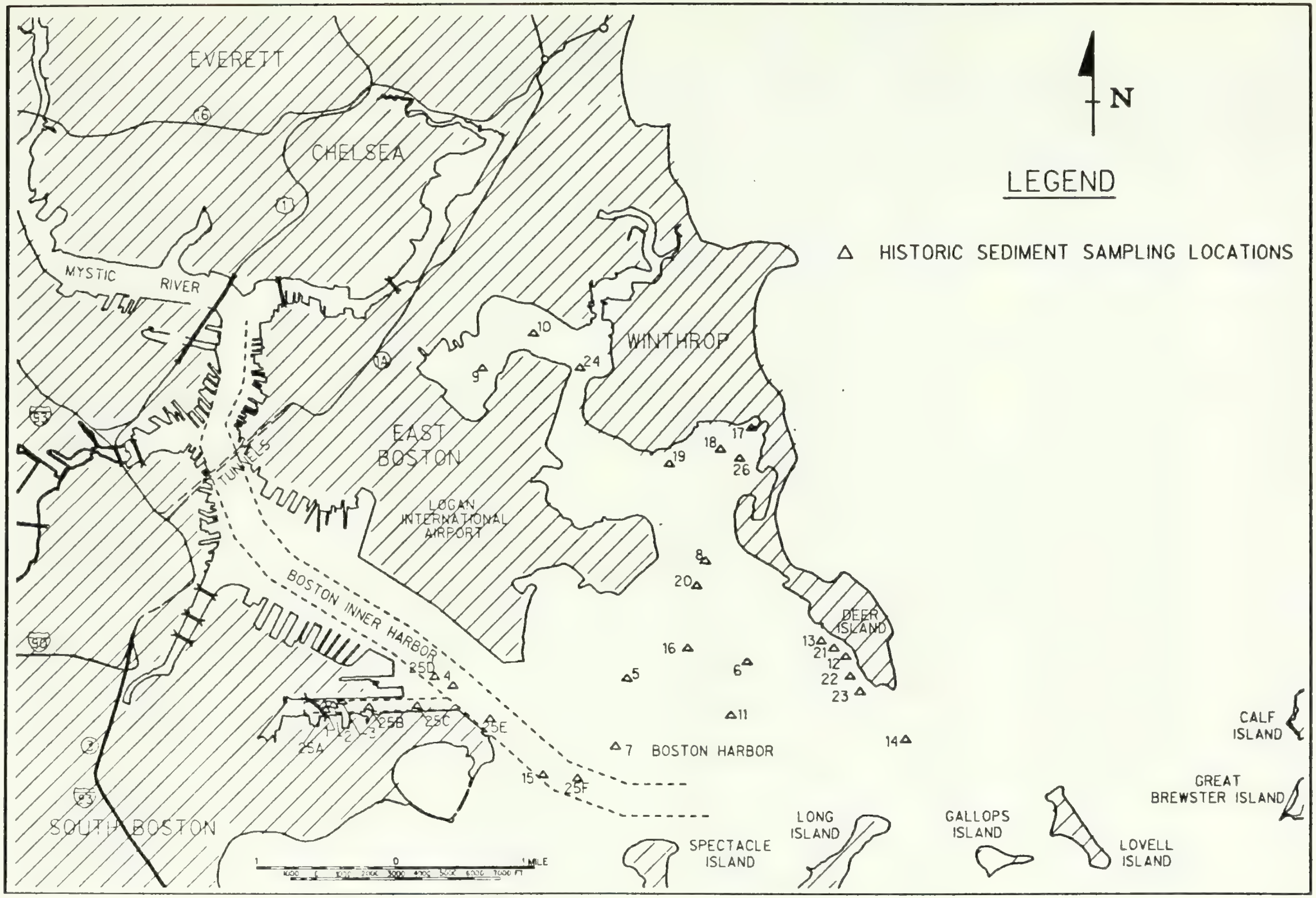
JULY

Species	Number
Winter Flounder	8
Rainbow Smelt	3
Windowpane Flounder	1
Alewife	1
Menhaden	1
American lobster	2
Jonah Crab	4

NOVEMBER

Species	Number
Winter flounder	29
Rainbow smelt	4
Windowpane flounder	3
Atlantic tomcod	1
Mackerel	1
Blueback herring	1
Longhorn sculpin	1
Jonah crab	17
Green crab	2

Source: Hubbard 1987



MASSACHUSETTS
WATER RESOURCES
AUTHORITY

FIGURE 3.8.4-1
HISTORIC SEDIMENT SAMPLING LOCATIONS
ALONG PROPOSED 115KV POWER SUPPLY ROUTES

Table 3.8.4-1 provides a summary of the available historic bulk sediment chemistry information for Boston Harbor in the vicinity of the proposed power routes from 1980 to prresent. The database contains both surface and core-composited data for metals, PCBs, PAHs. Physical data (e.g., grain size, percent volatiles, percent water, oil and grease) are also included where available. Figure 3.8.4-2 provides the mean and one standard deviation for each of the constituents.

As shown in Table 3.8.4-1, most of the historic sediment data are from surface samples (about 62 percent). A comparison of surface and composited core samples indicates that mean concentrations of metal contaminants are generally higher in surface sediments that in core samples (Figure 3.8.4-3). For example, mean concentrations of arsenic, cadmium, chromium, copper, lead, nickel, zinc and vanadium are higher in surface samples than in core samples (Table 3.8.4-2).

The exception to the metals is mercury, where concentrations in core samples are higher than surface samples. Mean mercury concentrations in surface samples were 0.81 ppm while core samples contained almost twice as much mercury, 1.71 ppm (Table 3.8.4-2).

Concentrations of organic contaminants do not follow any general pattern. Surficial sediments contain higher concentrations of PCBs than core sediments. The database is not sufficient, however, to draw firm conclusions for PAHs.

The historic data were analyzed statistically to determine if there are differences between surface and core samples along each route, and/or differences between northern and southern sediments. Results of the analysis are presented herein.

Surface Versus Core Samples

Analysis of 15 surface and 14 core (composite) sediments samples taken from Boston Harbor in the vicinity of the permanent northern (N-2) and southern power routes (S-1 and S-2) indicated that with, the exception of mercury (Hg), surface sediments do not contain statistically higher concentrations of most metals and PCBs than core sediments (a=.05). Table 3.8.4-2 lists the range, mean and standard deviation (SD) for each of the samples. Concentrations of arsenic, nickel, cadmium, lead, vanadium and zinc in surface sediments are higher than concentrations in core sediments; however, the difference is not statistically significant at a=.05 (Figure 3.8.4-3). Concentrations of copper in surface sediments is statistically higher than concentrations in core samples. In addition, concentrations of mercury in core sediments is significantly higher than concentrations in surface sediments at a=.05 (Table 3.8.4-2).

Northern Versus Southern Sediments

An analysis of northern and southern surface sediments was performed to determine if there is a significant difference between sediments. Tables 3.8.4-3 and 3.8.4-4 provide data on contaminants present in sediment samples taken from locations in the vicinity of the proposed southern and northern submarine power cable routes.

TABLE 3.8.4-1

SUMMARY OF BULK SEDIMENT CHEMISTRY DATA FROM BOSTON HARBOR STATIONS
ALONG THE PROPOSED SUBMARINE CABLE ROUTES SINCE 1980

SAMPLE	PARAMETER														
	As (ppm)	Cd (ppm)	Cr (ppm)	Cu (ppm)	Pb (ppm)	Hg (ppm)	Ni (ppm)	Zn (ppm)	V (ppm)	PCBs (ppm)	PAHs (ppm)	Silt/Clay (%)	O/G (%)	Volatiles (%)	Map Code	N/S
DIS-1 (C)	4.4	<0.32	38	17	16	0.11	13	50	--	0.01	---	29	0.00	2.78	12	S
DIS-2 (C)	4.6	0.55	68	38	50	0.41	12	82	--	0.02	---	75	0.02	5.26	12	S
DIS-3 (C)	5.7	1.0	115	56	74	0.37	16	130	--	0.12	---	50	0.06	13.1	12	S
DIS-4 (C)	4.2	1.1	99	48	38	0.30	14	93	--	0.22	---	54	0.03	5.41	12	S
DIS-5 (C)	3.2	0.89	86	43	51	0.33	12	95	--	0.02	---	37	0.01	4.87	12	S
DIS-6 (C)	4.6	2.4	190	92	76	0.56	19	170	--	0.33	---	47	0.08	5.42	12	S
DIS-1 (S)	5.1	0.79	110	65	56	0.41	13	85	--	0.16	---	27	0.06	3.68	12	S
DIS-5 (S)	5.7	2.5	230	150	110	0.74	24	220	--	0.13	---	64	0.12	8.36	12	S
DIN-1-2 (C)	4.1	0.81	78	44	560	0.44	15	93	--	0.07	---	48	0.05	5.26	13	S
DIN-4-6 (C)	3.8	<0.30	34	15	15	0.10	13	46	--	0.02	---	73	0.01	5.33	13	S
DIN-7-8 (C)	3.8	<0.26	28	12	10	0.06	11	39	--	0.05	---	62	0.03	3.41	13	S
DIN-9-10 (C)	3.7	0.44	44	26	35	0.10	11	31	--	0.09	---	77	0.04	3.45	13	S
DIN-4,5,6 (Surface)	4.3	0.33	40	19	20	0.11	13	56	--	0.10	---	28	0.06	4.12	13	S
E-1 (C)	11.1	<2.08	65.6	40.3	10.1	0.02	38.9	92.4	64.6	0.28	15.3	74	0.01	1.30	14	S
B-1 (C)	46.1	0.8	41.1	13.8	12.1	8.1	26.4	60.4	43.6	ND	---	96.5	0.03	2.31	1	S
B-2 (C)	51.4	1.0	49.4	18.7	12.9	9.7	32.7	72.2	51.5	.010[b]	---	97	1.49	3.23	2	S
B-3 (C)	16.8	1.7	77.0	67.8	63.2	3.4	22.0	105	49.5	.720[b]	---	60	4.41	20.72	3	S
S06 (S)	22	2.5	210	160	110	---	30	220	---	0.27[b]	<.50	---	---	---	4	S
S19 (S)	22	1.0	95	75	60	---	20	---	---	0.05[b]	<.49	---	---	---	8	N
S22A (S)	23	1.0	55	75	65	---	22	---	---	0.14[b]	<1.17	---	---	---	9	N
S23 (S)	10	2.0	148	104	100	---	21	156	---	0.61	<1.64	---	---	---	5	S
S23A (S)	5.3	2.4	164	128	112	---	24	156	---	0.52	<0.95	---	---	---	6	S
S24 (S)	11	2.4	168	120	132	---	24	156	---	0.26	<0.75	---	---	---	7	S
S22A (S)	--	1.6	84	108	100	0.47	28	188	---	<0.16[a]	---	---	---	---	9	N
										<0.17[b]	---	---	---	---		
CR02A (S)	--	0.8	48	40	72	0.13	8.0	108	---	<0.16[a]	---	---	---	---	10	N
										<0.56[c]	---	---	---	---		

TABLE 3.8.4-1 (Cont'd)

SAMPLE	PARAMETER															
	As (ppm)	Cd (ppm)	Cr (ppm)	Cu (ppm)	Pb (ppm)	Hg (ppm)	Ni (ppm)	Zn (ppm)	V (ppm)	PCBs (ppm)	PAHs (ppm)	Silt/Clay (%)	O/G (%)	Volatiles (%)	Map Code	N/S
CAN9 (S)	--	1.0	70	150	420	---	15.0	130	---	0.39	---	---	---	5.8	24	N
BH-1 (S)	--	---	---	---	---	---	---	---	---	.070	2.7	---	---	---	15	S
BH-2 (S)	--	---	---	---	---	---	---	---	---	.139	880	---	---	---	16	S
GE-7-80 (S)	3.7	4.0	111	26	25	0.7	9	60	40	1.2	---	47	0.14	3.10	11	S
GE-8-80 (S)	7.2	4.0	257	64	4.3	1.5	22	117	40	---	---	89	0.47	8.88	11	S
GE-9-80 (S)	8.3	1.0	225	49	43	1.4	20	153	40	---	---	85	0.43	7.14	11	S
DEM-A (S)	18.0	3.0	150	160	130	1.0	26	300	66	0.14	---	36.5	4.60	7.5	17	N
DEM-B (S)	23.0	2.2	190	150	120	0.8	26	180	62	0.17	---	28.0	3.9	7.4	18	N
DEM-C (S)	11.0	1.0	50	43	41	0.5	13	72	25	0.26	---	5.8	2.4	4.4	19	N
EG&G-23 (S)	48.0	5.6	350	240	170	2.2	44	380	120	0.55	---	52	0.10	6.0	23	S
EG&G-24 (S)	40.0	3.9	380	230	180	0.93	46	310	140	0.60	---	63	0.11	6.0	22	S
EG&G-25 (S)	27.0	1.4	120	97	97	0.61	22	120	64	0.12	---	17	0.10	3.0	21	S
EG&G-26 (S)	66.0	4.8	420	260	200	0.66	59	340	180	0.47	---	71	0.12	8.0	20	N
COE-A (S)	8.8	---	186	161	221	1.48	58	264	700	---	---	95	6.30	3.98	25A	S
COE-B (S)	5.4	---	93	73	84	0.55	56	178	700	0.77	---	79	0.59	3.46	25B	S
COE-C (S)	6.9	---	82	100	105	1.54	37	137	620	---	---	86	0.71	4.72	25C	S
COE-D (S)	7.2	---	109	67	109	0.41	37	136	690	---	---	95	3.20	9.28	25D	S
COE-E (S)	5.1	---	131	78	122	0.44	42	151	710	---	---	88	1.40	8.23	25E	S
COE-F (S)	5.3	---	101	84	101	0.48	40	128	710	---	---	85	1.30	6.93	25F	S
COE-A (S)	9.4	<3.0	66	65	<19	0.4	40	<2	<106	---	---	80	0.47	1.36	26	N
COE-B (S)	10.0	<3.0	61	62	32	0.3	38	157	<105	1.1	---	57.5	0.49	1.35	26	N
COE-C (S)	9.3	4.0	62	59	33	0.2	45	138	<109	---	---	95	0.43	1.68	26	N
COE-D (S)	2.1	8.0	25	20	<19	<0.1	32	80	---	---	---	97	0.04	2.66	26	N
COE-E (S)	6.9	13.0	110	93	80	0.7	41	134	<103	4.8	---	98	1.39	1.68	26	N
COE-F (S)	4.5	<3.0	109	100	61	0.6	32	154	<106	---	---	86	1.73	3.99	26	N
COE-G (S)	4.7	<3.0	75	76	60	0.5	--	137	<102	0.3	---	89	0.86	2.01	26	N
COE-H (S)	8.6	<3.0	76	68	37	0.3	35	135	<108	---	---	98	0.48	3.01	26	N
COE-I (S)	7.4	<3.0	142	169	97	<0.1	<29	173	<108	---	---	95	1.83	2.11	26	N
COE-J (S)	7.8	<3.0	87	76	51	0.5	<28	255	<103	---	---	97	0.89	2.11	26	N
COE-K (S)	3.3	<3.0	50	41	32	0.3	<29	78	<105	2.4	---	69	0.53	1.66	26	N
COE-L (S)	1.5	<3.0	<15	14	<19	<0.1	<29	43	<105	---	---	42.5	0.19	1.03	26	N

5181A-1649971-B4T

TABLE 3.8.4-1 (Cont'd)

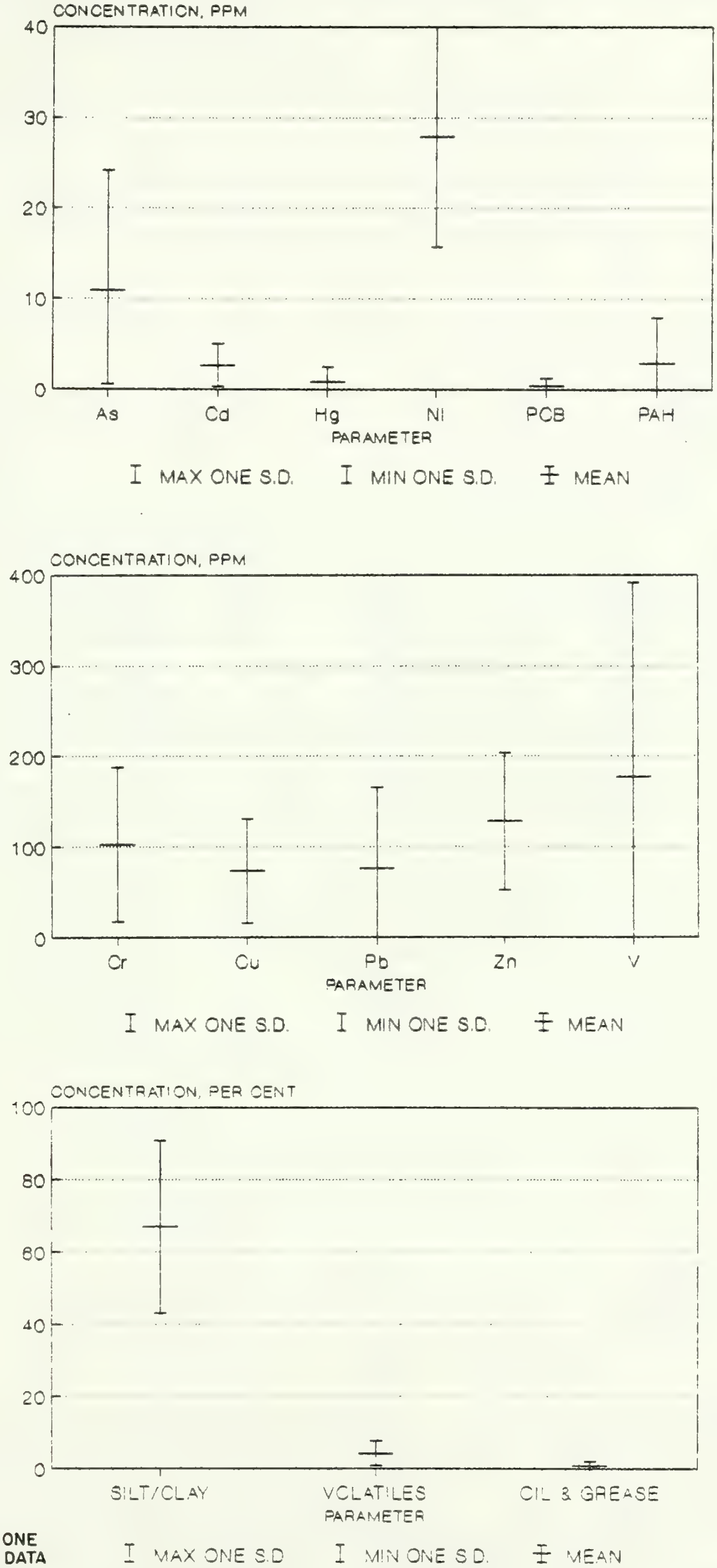
SAMPLE	As (ppm)	Cd (ppm)	Cr (ppm)	Cu (ppm)	Pb (ppm)	Hg (ppm)	Ni (ppm)	Zn (ppm)	V (ppm)	PCBs (ppm)	PAHs (ppm)	Silt/Clay (%)	O/G (%)	Volatiles (%)	Map Code	N/S
COE-A (C)	2.5	4.0	17	11	<18	<0.1	<28	69	<104	---	---	80	<.035	1.23	26	N
COE-B (C)	2.1	3.0	18	16	<19	<0.1	29	60	<106	---	---	96	<.035	2.42	26	N
COE-C (C)	2.2	4.0	<16	10	<19	<0.1	29	96	<108	---	---	72	<.035	1.52	26	N
COE-D (C)	4.8	12.0	97	87	62	0.7	48	134	---	---	---	70	.905	1.56	26	N
COE-E (C)	1.4	<3.0	15	<6	<19	<0.1	<28	38	<105	---	---	47.5	<.035	0.82	26	N
COE-F (C)	1.3	<3.0	15	19	<18	<0.1	28	87	<103	---	---	62	<.035	0.81	26	N
COE-G (C)	12.2	<3.0	63	66	49.5	0.7	47	171	114	---	---	81.5	.388	1.47	26	N
COE-H (C)	4.0	<3.0	74	47	41	0.5	<28	117	<104	---	---	71	.640	3.07	26	N
COE-I (C)	2.7	<3.0	<15	16	<18	<0.1	<28	100	<103	---	---	39	<.035	1.61	26	N
COE-J (C)	2.7	<3.0	18	17	<19	0.5	<29	57	<106	---	---	73.5	<.035	1.61	26	N
COE-K (C)	7.3	<3.0	163	82	80	0.8	31	89	<103	---	---	60	1.47	3.67	26	N
COE-L (C)	1.6	<3.0	16	14	<19	<0.1	<29	44	<105	---	---	42.5	<.035	0.81	26	N
Mean	10.91	2.70	102.9	73.4	76.6	0.84	27.9	128.2	177.1	0.44	2.93(1)	67.0	0.78	4.25		
Standard Deviation	13.25	2.34	85.4	57.7	89.1	1.64	12.2	76.1	213.7	0.82	5.04(1)	23.9	1.32	3.42		

NOTES: ND = Not Detected * Parts Per Billion (ppb)
NT = Not Tested
PCB[a] as Arochlor 1242
PCB[b] as Arochlor 1260
PCB[c] as Arochlor 1254

(C) = Core Sample
(S) = Surface Sample
N = North
S = South
Map Code: Number refers to location of historical and proposed sediment sampling stations in the vicinity of the power cable routes shown on Figure 3.8.4-1.

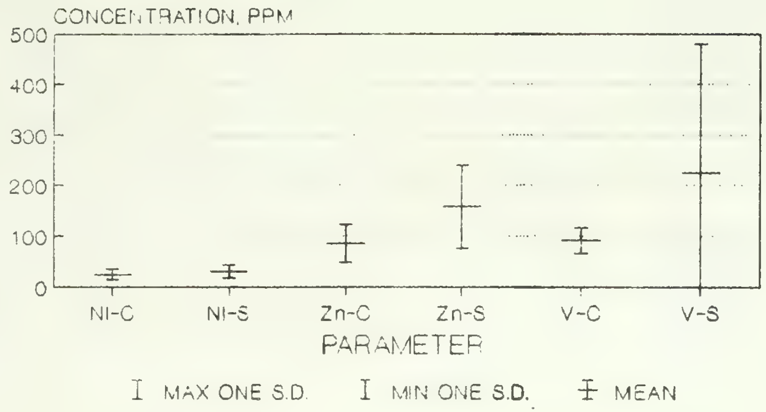
(1) Mean Based on 8 samples.

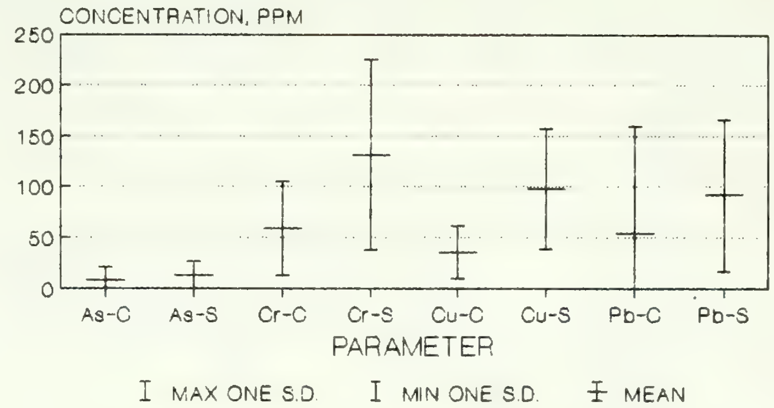
5181A-1649971-B4T

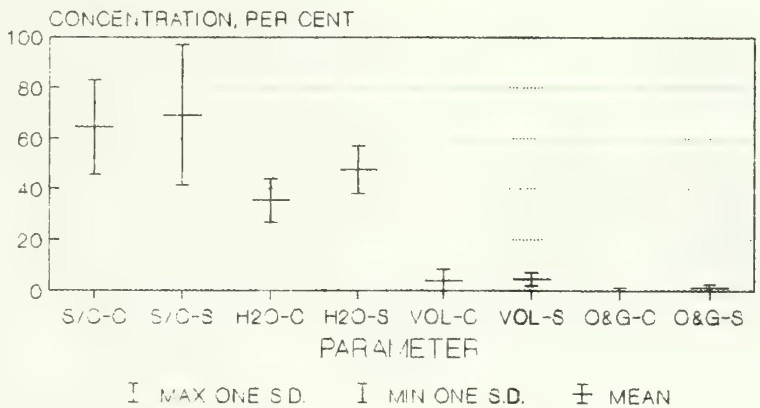


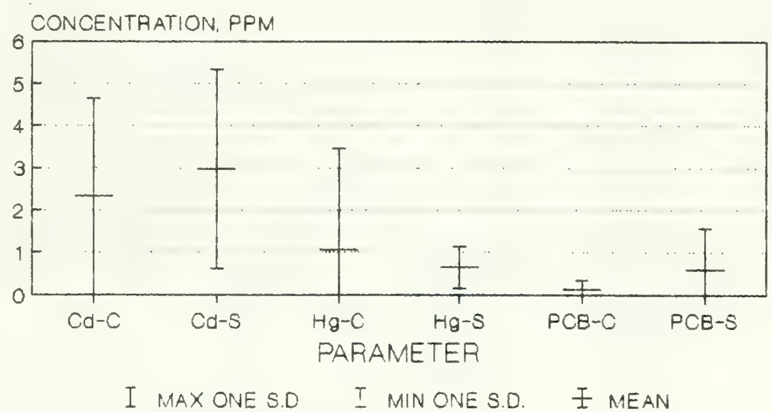
MEAN CONCENTRATIONS AND ONE S.D. RANGES SHOWN FOR ALL DATA

MASSACHUSETTS WATER RESOURCES AUTHORITY	FIGURE 3.8.4-2 SUMMARY OF SEDIMENT CHEMISTRY DATA SINCE 1980









MEAN CONCENTRATIONS AND ONE S.D. RANGES ARE SHOWN FOR ALL DATA; CORE SAMPLE CONCENTRATIONS ARE VERTICAL COMPOSITES

MASSACHUSETTS WATER RESOURCES AUTHORITY

FIGURE 3.8.4-3
COMPARISON OF SURFACE/CORE SEDIMENT ANALYSES

TABLE 3.8.4-2

COMPARISON OF SEDIMENT METAL DATA FROM SURFACE AND CORE SAMPLES ALONG THE PROPOSED SUBMARINE CABLE ROUTES

METAL	SEDIMENT CONCENTRATION (ppm)					
	Surface			Core		
	Range	Mean	S.D.	Range	Mean	S.D.
Arsenic	1.5-66.0	12.8	13.6	1.3-51.4	8.2	12.5
Cadmium	0.33-13.0	2.98	2.36	<0.3-12.0	2.33	2.32
Chromium	15-420	131	93.2	15-190	59.2	46.1
Copper	14-260	97.9	59.5	6-92	35.5	26.0
Lead	4.3-420	91.2	74.3	10-560	54.0	105.6
Mercury	.11-2.2	.65	0.50	.02-9.7	1.07	2.39
Nickel	8-59	30.2	12.8	11-48	24.5	10.5
Zinc	2-380	157.5	82.0	31-171	85.4	37.5
Vanadium	25-710	225	255	43.6-114	91.4	24.9
PCBs	0.05-4.8	0.59	0.98	0.00-0.72	0.14	0.20
PAHS	0.49-2.7	1.18	0.78	15.3	15.3	0
%Silt/Clay	5.8-98.0	69.2	27.7	29.0-97.0	64.4	18.6
%Volatiles	1.03-9.30	4.5	2.57	0.81-20.7	3.93	4.28
%Oil/Grease	0.03-6.30	1.14	1.50	0.00-4.41	0.35	0.92

Note: Includes data from 1980 to present.

TABLE 3.8.4-3

SUMMARY OF SEDIMENT CHEMISTRY DATA FOR THE PROPOSED SOUTHERN POWER ROUTES [1]

SAMPLE	PARAMETER													
	As (ppm)	Cd (ppm)	Cr (ppm)	Cu (ppm)	Pb (ppm)	Hg (ppm)	Ni (ppm)	Zn (ppm)	V (ppm)	PCBs (ppm)	PAHs (ppm)	Silt/Clay (%)	O/G (%)	Volatiles (%)	Map Code
DIS-1 (C)	4.4	<0.32	38	17	16	0.11	13	50	----	0.01	----	29	0.00	2.78	12
DIS-2 (C)	4.6	0.55	68	38	50	0.41	12	82	----	0.02	----	75	0.02	5.26	12
DIS-3 (C)	5.7	1.0	115	56	74	0.37	16	130	----	0.12	----	50	0.06	13.1	12
DIS-4 (C)	4.2	1.1	99	48	38	0.30	14	93	----	0.22	----	54	0.03	5.41	12
DIS-5 (C)	3.2	0.89	86	43	51	0.33	12	95	----	0.02	----	37	0.01	4.87	12
DIS-6 (C)	4.6	2.4	190	92	76	0.56	19	170	----	0.33	----	47	0.08	5.42	12
DIS-1 (S)	5.1	0.79	110	65	56	0.41	13	85	----	0.16	----	27	0.06	3.68	12
DIS-5 (S)	5.7	2.5	230	150	110	0.74	24	220	----	0.13	----	64	0.12	8.36	12
DIN-4,5,6 Surface)	4.3	0.33	40	19	20	0.11	13	56	----	0.10	----	28	0.06	4.12	13
DIN-1-2 (C)	4.1	0.81	78	44	560	0.44	15	93	----	0.07	----	48	0.05	5.26	13
DIN-4-6 (C)	3.8	<0.30	34	15	15	0.10	13	46	----	0.02	----	73	0.01	5.33	13
DIN-7-8 (C)	3.8	<0.26	28	12	10	0.06	11	39	----	0.05	----	62	0.03	3.41	13
DIN-9-10 (C)	3.7	0.44	44	26	35	0.10	11	31	----	0.09	----	77	0.04	3.45	13
S06 (S)	22	2.5	210	160	110	----	30	220	----	0.27[b]	<0.50	----	----	----	4
S23 (S)	10	2.0	148	104	100	----	21	156	----	0.61	<1.64	----	----	----	5
S23A (S)	5.3	2.4	164	128	112	----	24	156	----	0.52	<0.95	----	----	----	6
S24 (S)	11	2.4	168	120	132	----	24	156	----	0.26	<0.75	----	----	----	7
E-1 (C)	11.1	<2.08	65.63	40.3	10.1	0.02	38.9	92.4	64.6	0.28	15.27	74	0.01	1.30	14
B-1 (C)	46.1	0.8	41.1	13.8	12.1	8.1	26.4	60.4	43.6	ND	----	96.5	0.03	2.31	1
B-2 (C)	51.4	1.0	49.4	18.7	12.9	9.7	32.7	72.2	51.5	.010[b]	----	97	1.49	3.23	2
B-3 (C)	16.8	1.7	77.0	67.8	63.2	3.4	22.0	105	49.5	.720[b]	----	60	4.41	20.72	3
BH-1 (S)	----	----	----	----	----	----	----	----	----	.070	2.7	----	----	----	15
BH-2 (S)	----	----	----	----	----	----	----	----	----	.139	880[2]	----	----	----	16
GE-7-80 (S)	3.7	4.0	111	26	25	0.7	9	60	40	1.2	----	47	0.14	3.10	11
GE-8-80 (S)	7.2	4.0	257	64	4.3	1.5	22	117	40	----	----	89	0.47	8.88	11

[illegible]BLE [illegible]-3 ([illegible]nued

SAMPLE	PARAMETER														
	As (ppm)	Cd (ppm)	Cr (ppm)	Cu (ppm)	Pb (ppm)	Hg (ppm)	Ni (ppm)	Zn (ppm)	V (ppm)	PCBs (ppm)	PAHs (ppm)	Silt/Clay (%)	O/G (%)	Volatiles (%)	Map Code
GE-9-80 (S)	8.3	1.0	225	49	43	1.4	20	153	40	----	----	85	0.43	7.14	11
EG&G-23 (S)	48.0	5.6	350	240	170	2.2	44	380	120	0.55	----	52	0.10	6.0	23
EG&G-24 (S)	40.0	3.9	380	230	180	0.93	46	310	140	0.6	----	63	0.11	6.0	22
EG&G-25 (S)	27.0	1.4	120	97	97	0.61	22	120	64	0.12	----	17	0.10	3.0	21
COE-A (S)	8.8	----	186	161	221	1.48	58	264	700	----	----	95	6.30	3.98	25A
COE-B (S)	5.4	----	93	73	84	0.55	56	178	700	0.77	----	79	0.59	3.46	25B
COE-C (S)	6.9	----	82	100	105	1.54	37	137	620	----	----	86	0.71	4.72	25C
COE-D (S)	7.2	----	109	67	109	0.41	37	136	690	----	----	95	3.20	9.28	25D
COE-E (S)	5.1	----	131	78	122	0.44	42	151	710	----	----	88	1.40	8.23	25E
COE-F (S)	5.3	----	101	84	101	0.48	40	128	710	----	----	85	1.30	6.93	25F
MEAN	12.1	1.7	128	77.1	88.6	1.29	25.3	131.6	299.0	0.27	3.6	64.8	0.74	5.82	
STANDARD DEV.	13.8	1.38	87.0	59.0	100.5	2.24	13.5	78.4	313	0.30	5.75	23.5	1.47	3.81	
N=	34	27	33	33	33	29	33	33	16	27	6	29	29	29	

Notes: [1] Includes data from 1980 to present;
[2] Data not included in calculation of Mean.
[a] PCB as Arochlor 1242;
[b] PCB as Arochlor 1260;
[c] PCB as Arochlor 1254

TABLE 3.8.4-4

SUMMARY OF SEDIMENT CHEMISTRY DATA FOR THE PROPOSED NORTHERN POWER ROUTES [1]

SAMPLE	As (ppm)	Cd (ppm)	Cr (ppm)	Cu (ppm)	Pb (ppm)	Hg (ppm)	Ni (ppm)	Zn (ppm)	V (ppm)	PCBs (ppm)	PAHs (ppm)	Silt/Clay (%)	O/G (%)	Volatiles (%)	Map Code
S19 (S)	22	1.0	95	75	60	---	20	---	---	0.05[b]	<0.49	---	---	---	8
S22A (S)	23	1.0	55	75	65	---	22	---	---	0.14[b]	<1.17	---	---	---	9
S22A (S)	---	1.6	84	108	100	0.47	28	188	---	<0.16[a]	---	---	---	---	9
										<0.17[b]	---	---	---	---	
CR02A (S)	---	0.8	48	40	72	0.13	8.0	108	---	<0.16[a]	---	---	---	---	10
										<0.56[c]	---	---	---	---	
CA 9 (S)	---	1.0	70	150	420	---	15.0	130	---	0.39	---	---	---	5.8	24
DEM-A (S)	18.0	3.0	150	160	130	1.0	26	300	66	0.14	---	36.5	4.6	7.5	17
DEM-B (S)	23.0	2.2	190	150	120	0.8	26	180	62	0.17	---	28	3.9	7.4	18
DEM-C (S)	11.0	1.0	50	43	41	0.5	13	72	25	0.26	---	5.8	2.4	4.4	19
EG&G-26 (S)	66.0	4.8	420	260	200	0.66	59	340	180	0.47	---	71	0.12	8.0	20
COE-A (S)	9.4	<3.0	66	65	<19	0.4	40	<2	<106	---	---	80	0.47	1.36	26
COE-B (S)	10.0	<3.0	61	62	32	0.3	38	157	<105	1.1	---	57.5	0.49	1.35	26
COE-C (S)	9.3	4.0	62	59	33	0.2	45	138	<109	---	---	95	0.43	1.68	26
COE-D (S)	2.1	8.0	25	20	<19	<0.1	32	80	---	---	---	97	0.04	2.66	26
COE-E (S)	6.9	13.0	110	93	80	0.7	41	134	<103	4.8	---	98	1.39	1.68	26
COE-F (S)	4.5	<3.0	109	100	61	0.6	32	154	<106	---	---	86	1.73	3.99	26
COE-G (S)	4.7	<3.0	75	76	60	0.5	--	137	<102	0.3	---	89	0.86	2.01	26
COE-H (S)	8.6	<3.0	76	68	37	0.3	35	135	<108	---	---	98	0.48	3.01	26
COE-I (S)	7.4	<3.0	142	169	97	<0.1	<29	173	<108	---	---	95	1.83	2.11	26
COE-J (S)	7.8	<3.0	87	76	51	0.5	<28	255	<103	---	---	97	0.89	2.11	26
COE-K (S)	3.3	<3.0	50	41	32	0.3	<29	78	<105	2.4	---	69	0.53	1.66	26
COE-L (S)	1.5	<3.0	<15	14	<19	<0.1	<29	43	<105	---	---	42.5	0.19	1.03	26

SAMPLE	PARAMETER														
	As (ppm)	Cd (ppm)	Cr (ppm)	Cu (ppm)	Pb (ppm)	Hg (ppm)	Ni (ppm)	Zn (ppm)	V (ppm)	PCBs (ppm)	PAHs (ppm)	Silt/Clay (%)	O/G (%)	Volatiles (%)	Map Code
COE-A (C)	2.5	4.0	17	11	<18	<0.1	<28	69	<104	---	---	80	<.035	1.23	26
COE-B (C)	2.1	3.0	18	16	<19	<0.1	29	60	<106	---	---	96	<.035	2.42	26
COE-C (C)	2.2	4.0	<16	10	<19	<0.1	29	96	<108	---	---	72	<.035	1.52	26
COE-D (C)	4.8	12.0	97	87	62	0.7	48	134	---	---	---	70	.905	1.56	26
COE-E (C)	1.4	<3.0	15	<6	<19	<0.1	<28	38	<105	---	---	47.5	<.035	0.82	26
COE-F (C)	1.3	<3.0	15	19	<18	<0.1	28	87	<103	---	---	62	<.035	0.81	26
COE-G (C)	12.2	<3.0	63	66	49.5	0.7	47	171	114	---	---	81.5	.388	1.47	26
COE-H (C)	4.0	<3.0	74	47	41	0.5	<28	117	<104	---	---	71	.640	3.07	26
COE-I (C)	2.7	<3.0	<15	16	<18	<0.1	<28	100	<103	---	---	39	<.035	1.61	26
COE-J (C)	2.7	<3.0	18	17	<19	0.5	<29	57	<106	---	---	73.5	<.035	1.61	26
COE-K (C)	7.3	<3.0	163	82	80	0.8	31	89	<103	---	---	60	1.47	3.67	26
COE-L (C)	1.6	<3.0	16	14	<19	<0.1	<29	44	<105	---	---	42.5	<.035	0.81	26
MEA	8.74	3.49	77.8	67.9	61.7	0.38	30.5	125	102.1	1.02	0.83	69.3	0.54	1.88	
STA DARD DEV.	12.3	2.66	77.1	57.0	74.4	0.27	10.2	74.6	24.7	1.6	0.48	24.5	0.57	0.86	
=	30	33	33	34	34	30	32	31	26	16	2	28	24	24	

Notes: [1] Includes data from 1980 to present
[a] PCB as Arochlor 1242;
[b] PCB as Arochlor 1260;
[c] PCB as Arochlor 1254

A comparison of these data indicate that there are no statistically significant differences between concentrations of contaminants in sediments along the proposed north or south routes.

As shown on Table 3.8.4-5, concentrations of arsenic, copper, lead, zinc, and vanadium are only slightly higher in northern sediments than in southern sediments, while concentrations of chromium, nickel, cadmium, mercury, PAH and PCB are higher in southern sediments than in northern sediments.

The percent silt/clay fraction is higher in southern samples, consistent with the findings of higher concentrations of PCBs and PAHs in these sediments, since organic compounds would be expected to partition more readily to sediments with higher silt/clay fractions. The percent water, percent volatile solids and oil and grease concentrations are higher in northern sediments, however, the differences were not statistically significant.

MWRA Sediment Data

Figure 3.8.4-4 shows the locations of the sediment sampling stations along the proposed northern and southern submarine cable Routes, N-2 and S-1. Bulk sediment samples were collected by core in May 1988 and analyzed for physical characteristics and chemical composition (e.g., metals, PCBs, and PAHs). Table 3.8.4-6 provides the results of the sediment sampling program.

As shown on Figure 3.8.4-5, there are no apparent trends with respect to northern versus southern core sediments. Mean concentrations of arsenic, nickel, and vanadium are slightly higher in northern sediments; however, mean concentrations of cadmium, chromium, copper, lead, mercury, zinc, PCB and PAH are higher in southern sediments. There are no statistically significant differences between mean concentrations of contaminants in northern and southern sediments.

A comparison of the MWRA dataset with the historic dataset (Table 3.8.4-7) indicates that concentations of contaminants in sediments along the proposed submarine cable routes are generally consistent with those from past studies. There are marginal differences but these are probably the result of different sampling and analytical techniques. MWRA core composited samples were compared with sediment core samples from previous studies (Table 3.8.4-8), as well as to the overall (core plus surface samples) dataset. No significant differences or trends were observed. Mean concentrations of vanadium in historic samples were 3 to 6-fold higher than concentrations in MWRA samples; however, this was attributed to the high concentrations of vanadium in surface samples from the Reserved Channel and Main Ship Channel. Similarly, mean concentrations of mercury in historic sediment samples were 2 to 3-fold higher than concentrations in MWRA sediment samples.

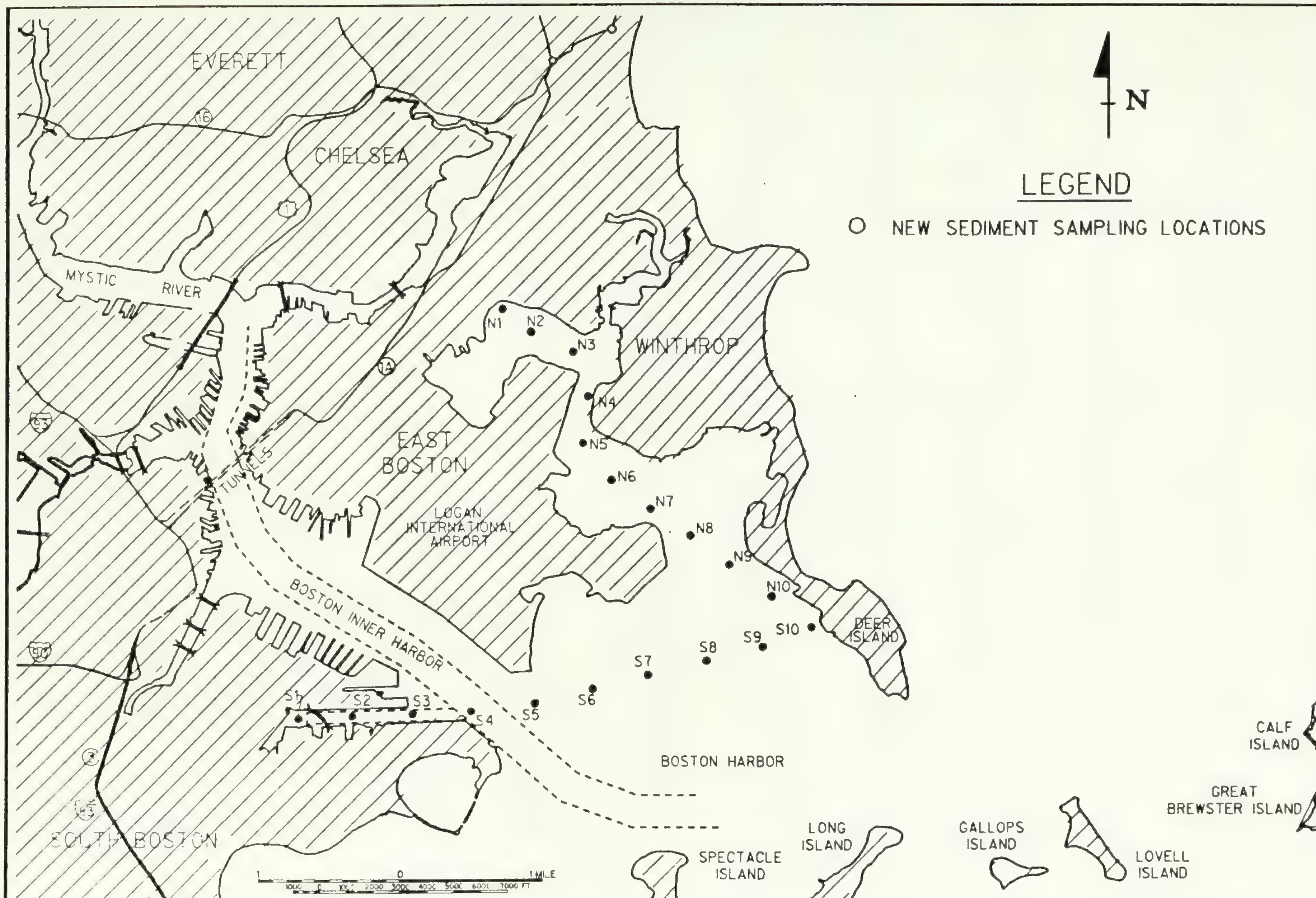
In summary, concentrations of contaminants in sediment samples from the proposed submarine power cable Routes N-2 and S-1 were generally consistent with concentrations reported in the historic database. Overall, mean concentrations of metals were similar to or lower than those reported previously in the literature. Mean concentrations of PCBs and PAHs were only slightly

TABLE 3.8.4-5

COMPARISON OF MEAN SEDIMENT SAMPLES
FOR NORTHERN AND SOUTHERN POWER ROUTES

ROUTE	MEAN CONCENTRATION													
	As	Cd	Cr	Cu	Pb	Hg	Ni	Zn	V	PCB	PAH	Silt/Clay (%)	O/G (%)	Volatiles (%)
	PPM													
North	8.74	3.49	77.8	67.9	61.7	0.38	30.5	125	102.1	1.02	0.83	69.3	0.54	1.88
n=	30	33	33	34	34	30	32	31	26	16	2	28	24	24
South	12.1	1.7	128.1	77.1	88.6	1.3	25	131.6	299	0.27	3.6	64.8	0.74	5.82
n=	34	27	33	33	33	29	33	33	16	27	6	29	29	29

5181E-1649971-B4T



MASSACHUSETTS
WATER RESOURCES
AUTHORITY

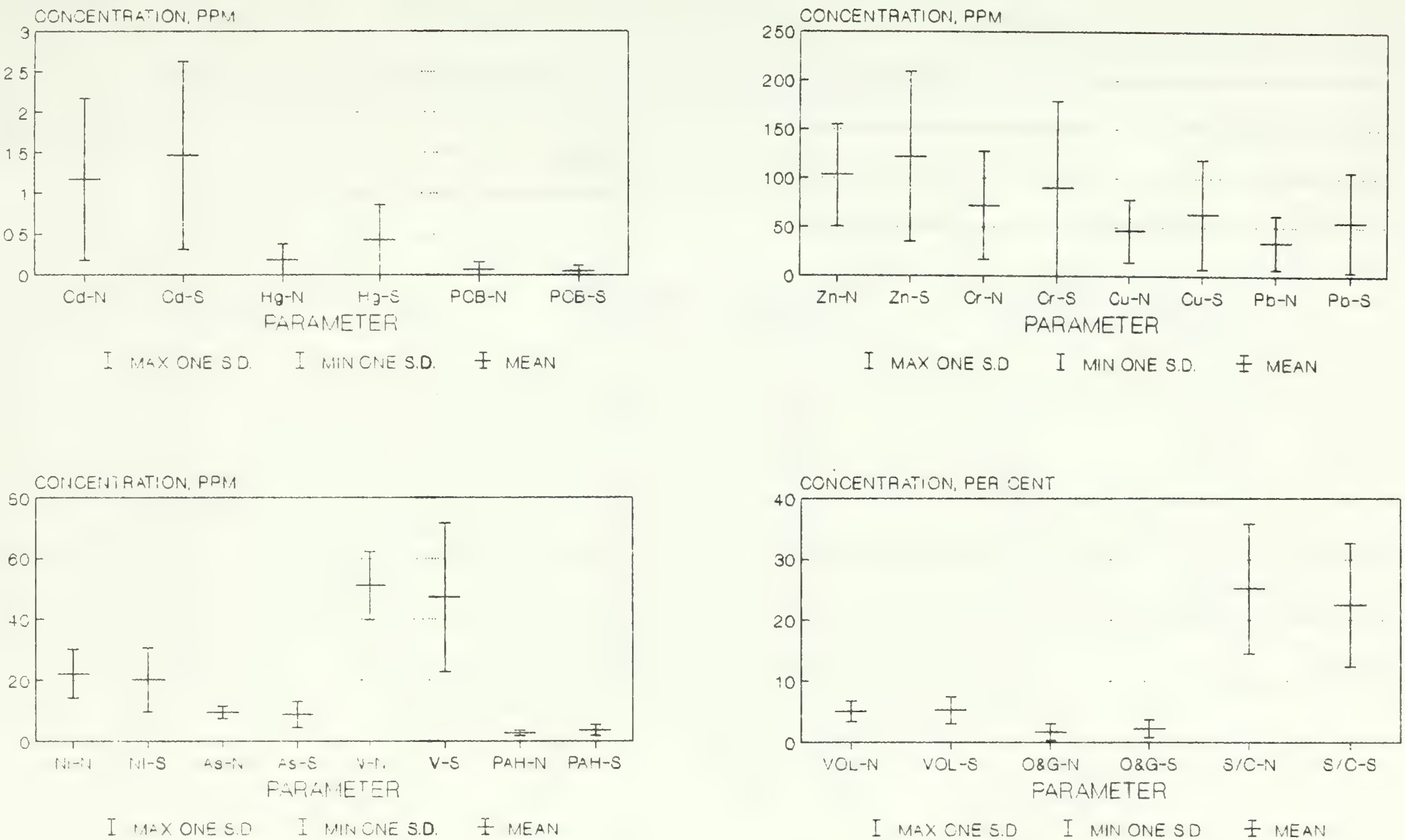
FIGURE 3.8.4-4
SEDIMENT SAMPLING LOCATIONS
FOR 115 KV POWER SUPPLY ROUTES

TABLE 3.8.4-6

SUMMARY OF MWRA SEDIMENT SAMPLING PROGRAM
MAY 1988

Constituent	Concentration (ppm)											
Station	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	Mean	S.D.
Arsenic	16	9.5	14	10	9.4	3.7	9.0	8.7	3.5	3.7	8.7	4.23
Cadmium	2	0.8	4	0.8	0.9	0.7	<0.9	3	<0.8	<0.8	1.47	1.16
Chromium	83	61	266	52	76	20	54	241	22	22	89.7	89.3
Copper	145	79	154	37	50	6.2	33	109	7.8	8.9	62.9	56.1
Lead	135	62	138	26	46	5.3	31	92	6.3	6.1	54.8	51.0
Mercury	0.6	0.6	1.4	0.1	0.8	<0.1	<0.1	0.3	<0.1	<0.2	0.43	0.43
Nickel	38	19	31	29	22	5	22	17	8	11	20.2	10.5
Zinc	227	128	277	90	109	32	84	204	34	35	122	86.8
Vanadium	95	39	82	50	45	22	43	50	22	24	47.2	24.5
PCB	0.24	0.28	0.039	0.02	0.04	0.02	0.02	0.02	0.02	.32	0.47	0.68
PAH	6.84	4.3	5.75	1.79	2.96	1.89	2.42	4.01	3.77	1.98	3.57	1.71
Silt/Clay (%)	27.5	9.4	27.4	9.9	17.2	12.4	21.0	29.1	32.1	38.8	22.5	10.1
Oil & Grease (%)	0.24	0.25	0.55	0.09	0.24	0.05	0.26	0.30	0.20	0.07	0.22	0.14
Volatiles (%)	8.0	5.4	8.3	3.3	4.9	2.2	4.8	8.0	3.4	4.0	5.2	2.2
Core Length (inches)	35.5	39	41	14	56	27.5	43	60	36.5	40.5	-	-
Station	N1	N2	N3	N4	N5	N6	N7	N8	N9	N10	Mean	S.D.
Arsenic	12	6.0	9	8	7.0	10	11	12	10	9.6	9.46	2.0
Cadmium	4	0.7	<1	<0.9	<0.9	<0.9	<0.8	<0.9	<0.8	<0.8	1.17	0.99
Chromium	224	65	51	44	32	50	47	68	75	60	71.6	55.0
Copper	133	40	26	28	21	35	38	41	54	45	46.1	32.0
Lead	103	35	18	18	13	22	19	19	53	44	34.4	27.4
Mercury	0.7	0.2	<0.1	<0.2	<0.09	<0.09	<0.09	<0.1	<0.2	<0.1	0.19	0.19
Nickel	35	7	22	22	12	25	19	26	28	25	22.1	7.98
Zinc	239	85	75	72	54	78	87	99	130	112	103	52.4
Vanadium	71	31	56	46	38	52	47	57	55	57	51.0	11.2
PCB	0.32	0.08	0.047	0.24	0.02	0.03	0.02	0.078	0.025	0.036	0.07	0.09
PAH	3.99	2.08	2.97	2.30	2.35	1.83	0.90	3.97	2.93	2.54	2.6	0.94
Silt/Clay (%)	30.4	16.2	43.2	29.9	37.6	14.8	25.4	27.9	13.6	12.6	25.2	10.1
Oil & Grease (%)	0.53	0.10	0.13	0.08	0.09	0.10	0.11	0.15	0.22	0.17	0.168	0.13
Volatiles (%)	8.64	2.94	6.86	4.25	3.82	3.79	4.45	4.92	5.66	4.84	5.0	1.7
Core Lenght (inches)	60	23.5	57.5	60.5	53	51.5	23	23	48	50.5	-	-

5276A-1649971-B4T



MEAN CONCENTRATIONS AND ONE S.D. RANGES ARE SHOWN FOR ALL DATA; COMPOSITED CORE SAMPLES; SILT/CLAY X 0.1

MASSACHUSETTS WATER RESOURCES AUTHORITY

FIGURE 3.8.4-5

COMPARISON OF NORTH/SOUTH SEDIMENT ANALYSIS- NEW MWRA PROGRAM RESULTS

TABLE 3.8.4-7

COMPARISON OF 1988 MWRA BULK SEDIMENT
CHEMISTRY DATA WITH HISTORIC BULK SEDIMENT CHEMISTRY DATA

Mean Concentration (ppm)

Constituent	Northern Route		Southern Route		Overall	
	MWRA	Historic	MWRA	Historic	MWRA	Historic
Arsenic	9.5	8.74	8.75	12.2	9.1	10.9
Cadmium	1.2	3.5	1.47	1.7	1.3	2.7
Chromium	71.6	77.8	89.7	128	80.6	103
Copper	46.1	67.9	63.0	77.1	54.5	73.4
Lead	34.3	61.7	54.8	88.6	44.6	76.6
Mercury	0.18	0.38	0.43	1.29	0.3	0.84
Nickel	22.1	30.5	20.2	25.3	21.1	27.9
Zinc	103	125	122	132	112.5	128.2
Vanadium	51	102	47.2	299	49.1	177.1
PCB	0.069	1.02	0.47	0.27	0.58	0.44
PAH	2.58	0.83	3.57	3.6	3.08	2.93

TABLE 3.8.4-8

COMPARISON OF CORE SEDIMENT SAMPLES

	Mean Concentration (ppm)			
	Northern Route		Southern Route	
Constituent	MWRA	Historic	MWRA	Historic
Arsenic	9.5	3.73	8.75	11.96
Cadmium	1.2	3.91	1.47	0.97
Chromium	71.6	43.9	89.7	72.4
Copper	46.1	32.6	63.0	37.9
Lead	34.3	31.8	54.8	73.1
Mercury	0.18	0.32	0.43	1.71
Nickel	22.1	29.5	20.2	18.3
Zinc	103	88.5	122	82.8
Vanadium	51	105.5	47.2	52.3
PCB	0.069	---	0.47	0.15
PAH	2.58	---	3.57	3.57

higher than those reported from the literature. Differences between the datasets were statistically insignificant.

3.8.5 SPECIAL HABITATS AND RESOURCES

No special habitats such as barrier beaches, freshwater wetlands or coastal dune communities are present along the proposed utility supply routes. In addition, no state or federally listed threatened or endangered fauna or flora are known to inhabit communities along the proposed utility routes.

The Massachusetts Natural Heritage Program has listed Snake Island as an habitat containing significant resources (COE, 1987). The state listed species of concern, least tern and common tern, have been known to nest on Snake Island. In 1986, three pair of least tern nested on Snake Island. In addition, the federally listed piping plover formerly nested on Snake Island. No plovers have nested on the island since 1983.

Section 3.8 References

Chesmore, A. P., S. A. Testaverde and F. P. Richards. 1971. A Study of the Marine Resources of Dorchester Bay. Monogr. Series No. 10, Massachusetts Division of Marine Fisheries, Boston, MA. 44 p.

EG&G WASC Oceanographic Services. 1984. Oceanography Study of Various Outfall Siting Options for the Deer Island Treatment Plant. Report prepared for Havens and Emerson/Parsons Brinckerhoff.

Hubbard, William A. 1987. A Draft Environmental Assessment of the Proposed Boston Harbor Improvement Dredging Project in Boston, Massachusetts. Environmental Resources Section, U.S. Army Corps of Engineers, Impact Analysis Branch, Waltham, MA. (May).

Massachusetts Department of Environmental Quality Engineering, Division of Water Pollution Control 1987. Boston Harbor 1986 Water Quality and Wastewater Discharge Data. Mass DEQE, DWPC, Technical Services Branch, Westborough, MA. (Sept.), Pub. No. 15,063-75-75-10-87-CR.

______________ 1986. Boston Harbor 1985 Water Quality and Wastewater Discharge Data. Mass. DEQE, DWPC, Technical Services Branch, Westborough, MA. (March). Pub. No. 14,471-80-20-10-86-CR.

Massachusetts Water Resources Authority. 1987 Secondary Treatment Facilities Planning Project Volume V, Appendix Z, Primary Productivity Program.

______________ 1987. On-Island Water Transportation Facilities for Deer Island and Nut Island. Facilities Plan and Environmental Document - Volume 7. Prepared for the MWRA by C. E. Maguire, October, 1987.

Massachusetts Water Resources Authority. 1987. Secondary Treatment Facilities Planning Project, Volume V, Appendix T, Benthic Biology.

Massachusetts Water Resources Authority. 1988. Results of Analysis of Boston Harbor Sediment Samples. Preliminary Report prepared by E3I, May 27, 1988.

Metcalf & Eddy, Inc. 1979. Application to the U.S. Environmental Protection Agency for the modification of secondary treatement requirements for discharge into marine waters of Boston Harbor and Massachusetts Bay for its Deer Island and Nut Island Wastewater Treatement Plants by the Commonwealth of Masssachusetts, Metropolitan District Commission. Prepared by M&E, Inc. for the MDC, Boston.

_____________. 1982. Report to the Commonwealth of Massachusetts, Metropolitan District Commission on the Nut Island Wastewater Treatment Plant facilities planning project: Phase I: Site Options Study. Prepared by M&E for the MDC, Boston, Mass.

New England Aquarium. 1974. Literature Survey of Boston Harbor. Prepared for Boston Edison Company, Boston, MA. (March).

Schwartz, J. P. 1987. PCB Concentrations in Marine Fish and Shellfish from Boston and Salem Harbors, and Coastal Massachusetts. Progress Report No. 14, 887-36-110-8-87-CR. Massachusetts Division of Marine Fisheries, Boston, MA.

South Essex Sewage District. 1986. Section 301(h), Revised Application for Modification of Secondary Treatment Requirements for Discharges into Marine Waters - Volume 3 - Biological Field Studies, prepared by Camp Dresser & McKee, November, 1986.

United States Army Corps of Engineers. 1987. Winthrop Harbor Navigation Improvement Project, Winthrop, Massachusetts. US COE, Impact Analysis Branch, Waltham, MA. Draft 12/7/87.

United States Environmental Protection Agency. 1986. Quality Criteria for Water 1986. USEPA, Pub. No. 440/5-86-001. Update No. 2 May 1, 1987.

United States Environmental Protection Agency. 1988. Boston Harbor Wastewater Conveyance System. Volume I of the Draft Supplemental Environmental Impact Statement, USEPA, Region I, Boston, MA. April 1, 1988 (Draft).

3.9 MARINE ARCHAEOLOGY

The three alternative submarine cable routes S-1, S-2, and N-2 are presented on Figure 3.8-1.

Utilizing the National Historic Preservation Act (NHPA) criteria as guidelines, more than three dozen published and unpublished sources were consulted in the documentation of historic wrecksites in inner Boston Harbor. Ranging in date from 1840 to 1988, these deocuments include

manuscripts, scholarly and popular articles, brochures, reports and books on the region's shipwrecks, storms, sportdiving, the port of Boston and the harbor islands. Various government publications also were consulted, including the weekly **Notice to Mariners** and the annual reports and special publications of the U.S. Coast Guard, the Massachusetts Humane Society, the U.S. Lifesaving Service, and the U.S. Army Corps of Engineers, New England District.

For construction projects that might affect the presence and/or preservation of historic shipwreck sites in inner Boston Harbor, reports and records maintained at the New England Division of the U.S. Army Corps of Engineers (COE) at Waltham, MA were consulted. These resources, located severally at the Division of Planning and Research, the Bureau of Navigation and the associated library and archives, are comprised of draft reports, published documents, maps and charts relating to COE activities and construction projects in Boston Harbor from 1925 to 1988.

Boston's inner harbor shoreline, from Grovers Cliff at Winthrop Highlands to the southern tip of Deer Island, contains one of the three highest concentrations of historic shipwreck sites in all of Massachusetts Bay. Approximately three miles in length, this section of coast incorporates 17 documented historic shipwreck sites ranging in date from an unidentified sloop that wrecked at Winthrop in 1682 to the 23-foot motor yacht **Moxie**, lost at Winthrop in 1917. The principal reasons for this high incidence of wreckings are the high volume of traffic along this beachline and the prevailing northeasterly storms and storm winds, which combined to drive vessels moving, mooored or anchored in the outer harbor against the shore. All of these wreckings occurred on the eastern (outer) side of this shore, itself outside the scope of this report. However, it is possible that some of these wrecks or their parts may have been forced into the inner harbor, either through Shirley Gut or from around the southern end of Deer Island. Shirley Gut, a section of open water between Point Shirley and Deer Island linking the inner and outer harbors, existed from the earliest settlement of Boston to as late as 1935. Because of the variable shape and depth of this topographical feature prior to its closure, it is not possible to predict the potential likelihood or frequency of occurrence of this hypothesis.

In 1980, the COE published the results of an extensive debris source inventory which cataloged all of the visible structures, including shipwreck sites, around Boston Harbor and the harbor islands. Studying the feasibility of removing various types of debris in order to improve harbor navigation and development possibilties, this shoreline survey did not locate any wrecksites within the area potentially impacted by the inner harbor submarine cable crossing. Nor are any wrecksites recorded along the proposed cable pathways upon the most recent navigational charts available to the public. Furthermore, this present study has not located any shipwreck sites of potential historic or archaeological significance within the potentially impacted areas.

This should not, however, necessarily suggest that such sites are not present, only that they are undocumented in the available literature. Among the categories of unrecorded sites that might exist in inner Boston Harbor are ships which may have sunk during storms or other

conditions of low visibility (such as fog), vessels (especially small craft) that sank at anchor and might not have warranted salvage, and vessels engaged in illicit or illegal activity unreported to the authorities.

Appendix C provides additional information on Marine Archaeology.

4.0 EVALUATION OF ALTERNATIVES

4.1 TECHNICAL EVALUATION OF ALTERNATIVES

4.1.1 CAPITAL COSTS

For comparison of alternatives, only the costs associated with installing the utilities off-site between the sources and Deer Island have been included. Costs associated with modifications of BECO's existing K-Street and Chelsea Substations are common to all alternatives and have not been included. These common costs are included in Section 5.2, Recommended Plan Cost.

As presented in this section, costs include a 35 percent allowance for engineering and contingency but exclude taxes under the Federal Tax Reform Act of 1986. Payments to a utility reimbursing costs for facilities to be owned by the utility are no longer exempt from Federal Taxation.

Northern Routes

To compare capital costs of the alternative northern routes, it is necessary to combine the costs for water, gas and permanent electric power. All three utilities could be routed along any of the five alternative N-1 routes, or water and gas could be routed along any of the five alternative N-1 routes and electric power could be brought in along Route N-2.

Table 4.1.1-1 presents the capital cost of the various northern route alternatives. The estimated capital cost to install water, gas and electric along the alternative N-1 routes varies from 20.0 to 21.4 million dollars. The difference is less than 10 percent. Therefore, based on capital cost, the five N-1 alternatives are judged to be nearly equal.

The estimated capital cost to install water and gas along an N-1 route coupled with the cost to install electric power along Route N-2 varies from 25.4 to 26.3 million dollars, 19 to 32 percent more than installation costs along Route N-1. Therefore, based on capital cost, installing water, gas and electric along one of the alternative N-1 routes is preferred.

Southern Routes

The estimated capital cost to bring electric power to Deer Island along Route S-1 is 12.0 million dollars. To install electric power along the alternative Route S-2, the estimated capital cost is 12.4 million dollars. Since the spread is less than 4 percent, these two alternatives are judged to be nearly equal based on capital cost.

4.1.2 RELIABILITY

Electric power is the most critical utility which must be supplied to Deer Island. If

TABLE 4.1.1-1

CAPITAL COST OF OFFSITE UTILITIES
NORTHERN ROUTE ALTERNATIVES

			Capital Costs (Million Dollars)				
ve	Route	Utilities Installed Along Route	Water Gas & Empty Ductbank(1)	Complete Electrical(2)	Water & Gas	Electrical	Total
	N-1	Water, Gas, Electric	13.2	6.8	---	---	20.0
	N-1A	Water, Gas, Electric	13.7	7.0	---	---	20.7
	N-1B	Water, Gas, Electric	14.3	7.1	---	---	21.4
	N-1C	Water, Gas, Electric	14.2	7.0	---	---	21.2
	N-1D	Water, Gas, Electric	14.1	7.0	---	---	21.1
	N-1	Water, Gas	---	---	8.5	---	
	N-2	Electric	---	---	---	16.9	25.4
	N-1A	Water, Gas	---	---	8.9	---	
	N-2	Electric	---	---	---	16.9	25.8
	N-1B	Water, Gas	---	---	9.4	---	
	N-2	Electric	---	---	---	16.9	26.3
	N-1C	Water, Gas	---	---	9.3	---	
	N-2	Electric	---	---	---	16.9	26.2
	N-1D	Water, Gas	---	---	9.1	---	
	N-2	Electric	---	---	---	16.9	26.0

(1) Empty electrical concrete ductbank installed between Chelsea Substation and Deer Island.

(2) Cable pulled from Chelsea Substation to Deer Island.

electrical power is interrupted, the wastewater treatment facility shuts down immediately. The plan to provide permanent electrical power includes three separate sources:

- o BECo's K-Street Substation capable of supplying 70 MW
- o BECo's Chelsea Substation capable of supplying 70 MW
- o On-site power plant capable of supplying 26 MW

The estimated peak and average electric demand at the treatment plant in 1999 is 64 MW and 37 MW, respectively. Considering that two diesel generators, each rated at 6 MW, are presently being installed, the overall plan for electrical power is highly reliable and is not affected by any of the alternative routes considered in this report.

The purpose of the following discussion is to assess the relative reliability of the northern alternatives (water, gas and electric) and to then compare the relative reliability of the southern alternatives (electric).

<u>Northern Routes</u>

The five alternative N-1 routes are overland between BECo's Chelsea Substation and Deer Island. Regardless of route, the total distance is nearly the same, varying between 33,500 ft for N-1 and 34,900 ft for N-1B. Therefore, distance is not a factor is assessing relative reliability.

To provide acceptably reliable services, all utilities will be installed underground. Proper design and construction should ensure trouble-free operation throughout the plant life. For example, the water main design will be ductile iron pipe (or equivalent), the gas main will be welded steel pipe, and the electric service will consist of cable pulled through a system of reinforced concrete ductbanks and manholes. These are materials of proven reliability.

These utilities will be placed in a buried trench and provided with a sound bed, proper compaction, and sufficient cover to ensure no damage due to live loads. The water and gas pipelines will be provided with adequate protection against corrosion. Also the utilities will be separated from each other by a minimum of 2 ft to allow for future access to any one utility without disturbing another.

Perhaps the worst postulated accident is a break in the water main. If undetected it could wash out a section of roadway, undermine the bedding around the other utilities, and lead to a disruption in service until the water main and roadway could be repaired. As mentioned above, suitable redundant sources of electrical power would be available to the treatment plant. The temporary loss of water and gas would not affect plant operations.

Three of the five alternative N-1 routes (N-1, N-1A, N-1D) traverse Yirrell Beach in Winthrop on the ocean side of the existing seawall. Based on a review of available literature, this stretch of beach is depositional and utilities buried adjacent to the seawall should be safe

from storm damage. For facilities planning, it is reasonable to assume that these routes offer the same high reliability as the all-road alternatives N-1B and N-1C. However, this must be confirmed during detailed design.

Route N-2 is an alternative to carry electric power from the Chelsea Substation to Deer Island. Its length is 32,500 ft, including 18,800 ft underwater. The mostly overland section between the Chelsea Substation and Orient Heights Beach would be installed in a concrete ductbank and buried in a trench within existing road right-of-ways wherever possible. To cross the Chelsea River, the cable would be pulled through existing ductbanks previously installed by BECo. To cross the MBTA tracks at Orient Heights, the cable would be pulled through a pipe which would be jacked under the tracks. Along the underwater section, the cables would be armor protected and embedded in a plowed trench. The embedded depth would be sufficient to protect the cable from physical damage. Because the utility is buried along its entire route, it is well protected from damage.

If Route N-2 is utilized for electric power, it must be coupled with one of the N-1 routes carrying water and gas. One advantage of this arrangement is that a failure along one route will not affect all three utilities.

In summary, all of the northern routes provide acceptable reliability for offsite water, gas, and electric utilities. The overall plan to provide electric power from two offsite sources (100 percent redundant) and an on-site power plant provides a highly reliable electrical power supply.

<u>Southern Routes</u>

Two alternative routes for electric power connect BECo's K-Street Substation and Deer Island. Route S-1 is 21,400 long and is almost entirely underwater. The cable would exit the K-Street Substation and run cross-country in a trench to the Reserved Channel. The cable would be embedded in a plowed trench under the Reserved Channel and across the main ship channel to Deer Island. The final embedment design will depend on soil conditions. It will, however, be embedded sufficiently deep into the soil or rock such that it will be protected against damage from anchor dragging. Any underwater cable design in a navigable waterway must consider anchor dragging. For this particular project, the cable is crossing the main shipping channel of a major seaport (Boston) and it is running adjacent to a designated anchorage area. Therefore, very careful consideration must be given to the embedment design to provide a reliable service.

Route S-2 is 23,100 ft long. Approximately 10,000 ft is overland, mostly in road right-of-ways; the remainder is underwater. The underground portion would be installed in a concrete ductbank buried in a trench. The underwater portion would be embedded in a plowed trench, similar to that described above for Route S-1. Although the length of underwater cable for Route S-2 (13,100 ft) is less than the underwater length for Route S-1 (20,400 ft), it still crosses the main shipping channel and runs adjacent to the anchorage area. Therefore, it is subject to the same potential anchor dragging damage as described for Route S-1.

In summary, both southern routes provide acceptable reliability for one offsite source of electric power. Again, the overall plan to provide two offsite sources and an onsite power plant provides a highly reliable electrical power supply.

4.1.3 CONSTRUCTIBILITY

The constructibility of utilities along the various routes may be separated into overland and underwater construction. Constructibility is rated normal for the overland routes (N-1, N-1A, N-1B, N-1C, N-1D) and difficult for the underwater routes (S-1, S-2, N-2).

<u>Overland Routes</u>

The entire length of the five alternative N-1 routes and significant portions of Routes N-2 and S-2 are overland. Construction requirements, sequence, and special considerations are discussed in Section 2.5.1. Overland installation of water, gas, and electric utilities will follow standard utility procedures. Local contractors are qualified to install the utilities in accordance with MWRA, BECo, and Boston Gas Co. requirements. Construction equipment and labor is available locally and all material can be manufactured and delivered from numerous suppliers in a timely manner.

The degree of construction difficulty will depend on existing subsurface conditions which must be determined during detailed design. Major items include:

- Location, type, and condition of existing utilities (water, gas, electric, sewer, telephone, cable). For example, this information will determine whether a common trench or separate trenches are required to avoid interferences. Also, it may be necessary to relocate or replace existing utilities.

- Ground Conditions. The existing subsurface conditions will determine the suitability of excavated materials for bedding and backfill. Also, it will identify where dewatering and/or rock blasting could be required.

- Stability of Adjacent Structures and Slopes. Depending on the length and depth of open trench cut, soil conditions, need for dewatering, and the proximity and condition of adjacent structures, special considerations may be required. These could include minimizing the length of open cut, bracing the trench walls, or other means of soil support.

All of the above items must be carefully addressed during detailed design. With adequate field survey information and proper engineering, all of these potential problems can be resolved. These are normal items which are encountered with any new utility installation in a populated area.

It should be possible to maintain any reasonable construction schedule. Typically, installation for similar work could be expected to proceed at an average rate of approximately 100 to 200 ft per day. Upon completion of field surveys and detailed design, estimates of advance rates for this project can be made. It is expected that the contractor will mobilize at least two separate work crews for this project. However, if necessary to meet schedule, it will be possible to work several segments of the route concurrently either by one or two contractors. For a more detailed discussion regarding schedule, see "Timely Implementation" below.

In summary, the constructibility along all overland routes is judged to be normal. Overland routes include all of N-1, N-1A, N-1B, N-1C, N-1D, and portions of N-2 and S-2.

Underwater Construction

Essentially all of Route S-1 (20,400 ft) and significant portions of S-2 (13,100 ft) and N-2 (18,800 ft) are underwater. Electric power is the only utility which is being considered for underwater installation. Construction requirements and sequence are discussed in Section 2.5.2.

The constructibility along any of the underwater routes is rated difficult due to the following factors:

- Marine Construction. Delays due to bad weather and a winter season shutdown are much more likely for marine construction than on-land work. Strong currents and high waves can make construction difficult. For Routes S-1 and S-2, careful coordination with the U.S. Coast Guard concerning ship traffic is also necessary. However, all of the routes are within Boston Harbor and are never more than one mile from land. In relative terms, this is not a severe environment for marine construction.

- Specialty Cable. Due to the underwater environment, the installation technique, and the difficult accessibility for repair, the cable is a special design. Based on a preliminary design, BECo has selected three single core, oil filled, 115 kV armor protected cables for one circuit. Preferably, each cable will be manufactured and wound onto a reel and shipped to the site as one continuous length. Based on preliminary investigations, there are approximately six qualified cable suppliers throughout the world.

- Specialty Contractors. High voltage submarine power cables have been successfully installed throughout the world for over 30 years. However, each installation is generally unique to any one area. Also, as described in Section 2.5.2, the equipment required to cut a trench through soil and rock and embed the cable is special. Consequently, the number of qualified

contractors is limited. Based on preliminary investigations, there are several qualified contractors throughout the world. It should be noted that the rock saw has been successful in rock with compressive strengths under 23,000 psi. The suitability of the rock saw trenching method in Boston Harbor must be confirmed by marine borings and lab testing. If the rock saw was not compatible, it would be necessary to excavate the trench by conventional drill and blasting techniques.

Construction schedule will primarily depend on existing sub-bottom conditions. Field surveys must be conducted prior to requesting bids for the installation. Among other items, the survey must identify the bottom profile and the top of rock profile. The advance rate for trenching through rock is currently estimated at 100 ft per day. Through soil, this rate increases to 500-600 ft per day. In contrast to the overland construction, only one specialty marine contractor will be mobilized to embed the cable. Therefore, schedule is directly related to sub-bottom conditions. For a detailed discussion regarding schedule, see "Timely Implementations" below.

In summary, the constructibility along all underwater routes (S-1, S-2, N-2) is rated difficult.

4.1.4 TIMELY IMPLEMENTATION

The overall plan to bring all offsite utilities to Deer Island includes:

- Water from MWRA's Meter 41 at the Winthrop/Revere town line
- Gas from Boston Gas Company's supply at Railroad Avenue in Revere
- Interim and permanent power from BECo's K-Street Substation
- Permanent power from BECo's Chelsea Substation.

Water and gas will be installed concurrently along one of five alternative N-1 routes. Power from K-Street will be installed along one of two alternative southern routes (S-1 or S-2). Power from Chelsea will be installed along one of the five alternative N-1 routes or along Route N-2. When combined into an overall plan for offsite utilities there are twenty possible alternatives. These can be visualized by separately combining S-1 and S-2 to each of the ten alternatives listed in Table 4.1.1-1. Many of these alternatives are similar and can be grouped together as a single alternative for comparing implementation times.

<u>Northern Routes</u>

Water and gas, or water, gas, and an empty electrical ductbank, will be installed concurrently along one of the five alternative N-1 routes. These routes are all overland and are approximately the same length. There does not appear to be significant differences in construction schedule for these alternatives. For the purpose of comparing implementation

times, these routes can be considered one alternative.

Southern Routes

Interim and permanent power will be installed along either Route S-1 or Route S-2. Both routes are nearly the same length and both require substantial underwater construction across the main shipping channel.

Route S-1 is mostly underwater (20,400 ft) while S-2 is almost equally split between underwater (13,100 ft) and overland (10,000 ft) construction. For the underwater installation, as described in Section 2.5.2, rock trenching along Route S-1 is assumed to require 17 weeks. For S-2, rock trenching could be theoretically reduced from 17 to 11 weeks. However, the time for mobilization (12 weeks), trial runs (2 weeks) and cable installation (3 weeks) would be essentially the same for either route. Therefore, there is only a 6 week difference in underwater installation schedules between S-1 (34 weeks) and S-2 (28 weeks).

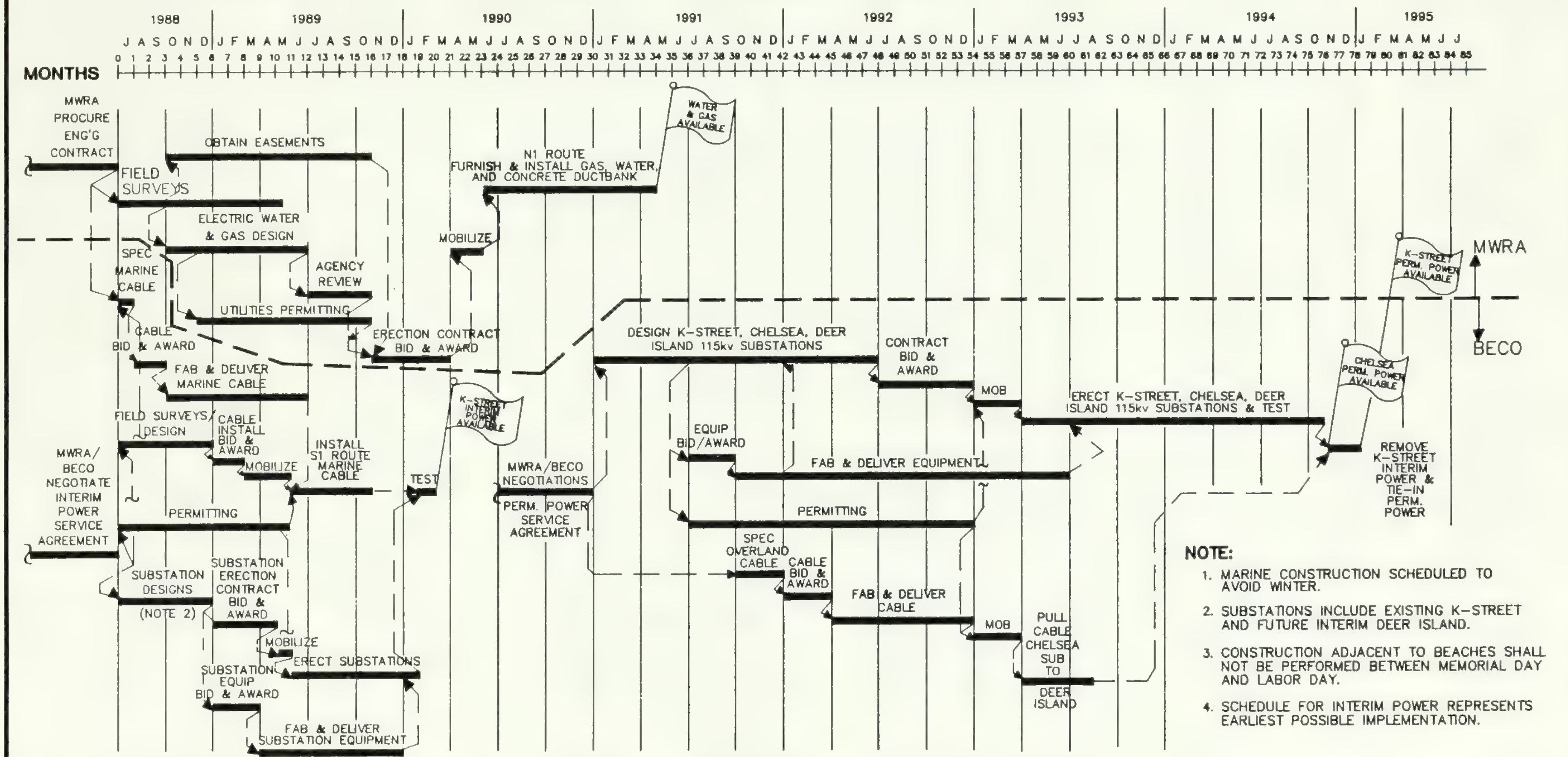
Route S-2 also involves 10,000 ft of overland construction, primarily in existing roads. Assuming an estimated advance rate of 100 ft per day, the installation of a ductbank could require 17 weeks. Allowing for mobilization time (4 weeks) and cable pulling and splicing after ductbank completion (12 weeks), the overland portion could require 33 weeks, which is more time than the underwater portion of S-2 (28 weeks) and nearly the same amount of time as S-1 (34 weeks).

For the purpose of comparing implementation times, these routes can be considered one alternative. For schedule purposes, S-1 has been shown.

Based on the above grouping of the N-1 routes and the southern routes, the original twenty alternatives can be reduced to two, depending on whether permanent power from Chelsea is installed along an N-1 route or along Route N-2. Figure 4.1.4-1 presents an implementation schedule for all offsite utilities assuming that the permanent power from Chelsea is installed along one of the N-1 routes. This schedule can be analyzed as three separate projects.

- Water, Gas and Empty Electrical Duct Bank. The MWRA will be responsible for installing water, gas and an empty concrete ductbank along an N-1 route. The duct bank will be installed along the entire N-1 route between the Chelsea Substation and Deer Island. The gas main will originate at Railroad Avenue in Revere and the water line will begin at Meter 41 near the Winthrop/Revere town line. Field surveys should be initiated as soon as possible during 1988 in order to identify existing utilities and subsurface conditions, survey cross-country routes, and identify property ownership and easement requirements. Easements should be obtained as required, particularly if one of the beach routes is selected.

  Design, permitting, and agency reviews should proceed concurrently in 1989. Construction should begin in early 1990. The distance between the Chelsea Substation and Deer Island is less than 35,000 feet. Assuming two crews are working independently at an average



NOTE:

1. MARINE CONSTRUCTION SCHEDULED TO AVOID WINTER.
2. SUBSTATIONS INCLUDE EXISTING K-STREET AND FUTURE INTERIM DEER ISLAND.
3. CONSTRUCTION ADJACENT TO BEACHES SHALL NOT BE PERFORMED BETWEEN MEMORIAL DAY AND LABOR DAY.
4. SCHEDULE FOR INTERIM POWER REPRESENTS EARLIEST POSSIBLE IMPLEMENTATION.

MASSACHUSETTS WATER RESOURCES AUTHORITY

FIGURE 4.1.4-1
OFFSITE UTILITIES SCHEDULE
CHELSEA PERM. POWER ROUTE N1(A-D)

MWRA_A1
8-10-88

installation rate of 100 ft per day, the construction time is estimated to require eight calendar months. Allowing for a 3 month winter shutdown, it is estimated that water and gas will be available at Deer Island in April, 1991. The ability to implement this project on schedule is given a moderate rating.

- Interim Power. BECo will be responsible for installing an interim power service from its K-Street Substation in South Boston to Deer Island. The scheduled in-service date of March, 1990 is extremely optimistic and it will be very difficult to achieve.

  To have any hope of achieving this schedule, several steps must be taken immediately. First, MWRA must sign an interim power service agreement, or as a minimum, a letter of understanding with BECo. This agreement should authorize BECo to install the interim power service.

  BECo must immediately begin to work towards the earliest possible inservice date by concurrently initiating field surveys, engineering and design, and permitting. Field surveys must be conducted in the summer and fall of 1988 to determine sub-bottom conditions along the route. (Since MWRA already has or will shortly have the appropriate contractors performing similar work for the outfall system, it is recommended that an amendment to these existing contracts be considered.) This information must be supplied in the request for bids to the cable installer. If the cable is to be embedded across the harbor in 1989, it is imperative that the cable installation contract be awarded no later than March, 1989.

  This by itself presents another problem. Preferably, as indicated by industry practice, the cable supplier requested to furnish and install the cable. This places the entire responsibility for a successful installation on one contractor. However, sub-bottom information may not be known prior to placing an order for the cable. The cable lead time is six to nine months and it must be at the site in the summer of 1989. If sub-bottom information is not available in time to support a fixed price bid for the installation, it is recommended that the cable supplier be requested to provide unit pricing for the installation. BECo should retain the option to have the cable manufacturer install the cable based on the unit pricing. Although not preferred, BECo's other option would be to separately bid the installation.

  As previously discussed, the cable installation is estimated to require eight months (12 weeks for mobilization, 2 weeks for trial runs, 17 weeks for rock trenching, and 3 weeks for cable installation). The largest unknown is the amount of rock trenching required; it is assumed to be 50 percent of the route. Schedule will be linearly affected depending on the validity of this assumption. This will be determined by the field surveys.

  Aside from the tight engineering, manufacturing, and construction schedules, permitting could be the critical path. A total of eleven months are shown for all permitting activities, which include both preparation of permit applications and reviews/approvals by the appropriate agencies. All necessary permits/approvals are assumed to be obtained by June 1, 1989. It should be noted that the cable and equipment are being fabricated prior

to receipt of all permits and approvals. This exposes MWRA to some risk. However, if release for fabrication is held until completion of permitting, the earliest in-service date would slip from March, 1990 to late 1990.

The maximum time period allowed for agency reviews in this schedule is six months; completion of engineering/design activities required for preparing the permits would be in November, 1988. An additional one to three months would be available for agency reviews of certain applications such as the Approval by the Energy Facilities Siting Council, the Section 10 permit (COE), and for partial submittals of the Chapter 91 Waterways License. Beyond the end of the permit schedule on June 1, 1989, an additional one to two months could be available for agency review. However, any additional time for permitting will result in a corresponding decrease in the available construction time required for the submarine cables; alternatively, submarine cable construction could be extended during November and December, 1989, to allow for an additional one to two months for permit reviews by agencies.

The permitting schedule represents a best case situation and provides a minimal degree of flexibility; the impact of appeals on certain of the requisite permit applications would extend the overall implementation of the project. The ability to implement this project on schedule is given a very difficult rating. Any schedule slippage would probably push the installation to early 1990, in which case, the inservice date would be late 1990.

o Permanent Power. Installation of permanent power is shown to support an in-service date of January, 1995. To initiate this effort, MWRA and BECo should sign a permanent power service agreement in January, 1991. A four year schedule appears to be very conservative but longer than normal lead times have been identified for SF-6 substation equipment based on recent BECo experiences. Installation of permanent power earlier than January, 1995 is however, expected.

Permitting requirements for completing the permanent power are less than for the interim power supply since these activities do not involve construction below the mean high water line.

Power from Chelsea will be installed along one of the N-1 routes. During installation of water and gas in 1990 and 1991, an empty concrete ductbank will also be constructed along the entire route from Chelsea Substation to Deer Island. Therefore, in 1993, the cable must then be pulled the entire length of 35,000 ft. Assuming two crews, the cable can be installed in approximately five months.

To receive this power, a new 115 kV gas insulated (SF-6) substation will be erected at Deer Island. Upon completion of the new substation and modifications to the Chelsea Substation, power will be available from Chelsea. At that time, the K-Street interim source will be de-energized to allow permanent power tie-ins at both K-Street and the new Deer Island Substation. The underwater cable installed from K-Street for interim power is sized to also handle the permanent power. Therefore, permanent power will then be available from two sources.

The ability to implement the permanent power according to schedule is rated moderate.

Figure 4.1.4-2 presents the schedule for the second alternative, where permanent power from Chelsea is installed along Route N-2. As with the first alternative described above, this may be divided similarly into three projects: water and gas; interim power; and permanent power.

The discussion for water and gas is identical to the first alternative except that an empty ductbank would not be installed. The ability to implement installation of water and gas according to the schedule is rated moderate.

The discussion for interim power is also identical to the first alternative. The ability to implement interim power from K-Street by March, 1990 is rated very difficult.

The implementation time for permanent power is identical to the first alternative. Permanent power from Chelsea and K-Street will be in service by January, 1995. The service agreement for permanent power should be signed by MWRA and BECO in January, 1991. The new Deer Island Substation and the modifications at Chelsea and K-Street are identical to the first alternative. The only difference between the alternatives is the route from Chelsea to Deer Island. Route N-2 is 32,500 ft long, including an underwater length of 18,800 ft. As shown on the schedule, utilizing the same advance rates as described earlier, the overland and underwater cable could be completely installed in 1993, leaving slack time in 1994. As with the first alternative, erection of the new Deer Island Substation is on the critical path.

The permitting requirements for this alternative would be more difficult than the N-1 route because Route N-2 involves underwater construction. However, it should be similar to the interim power and this permitting can certainly be accomplished within the overall schedule.

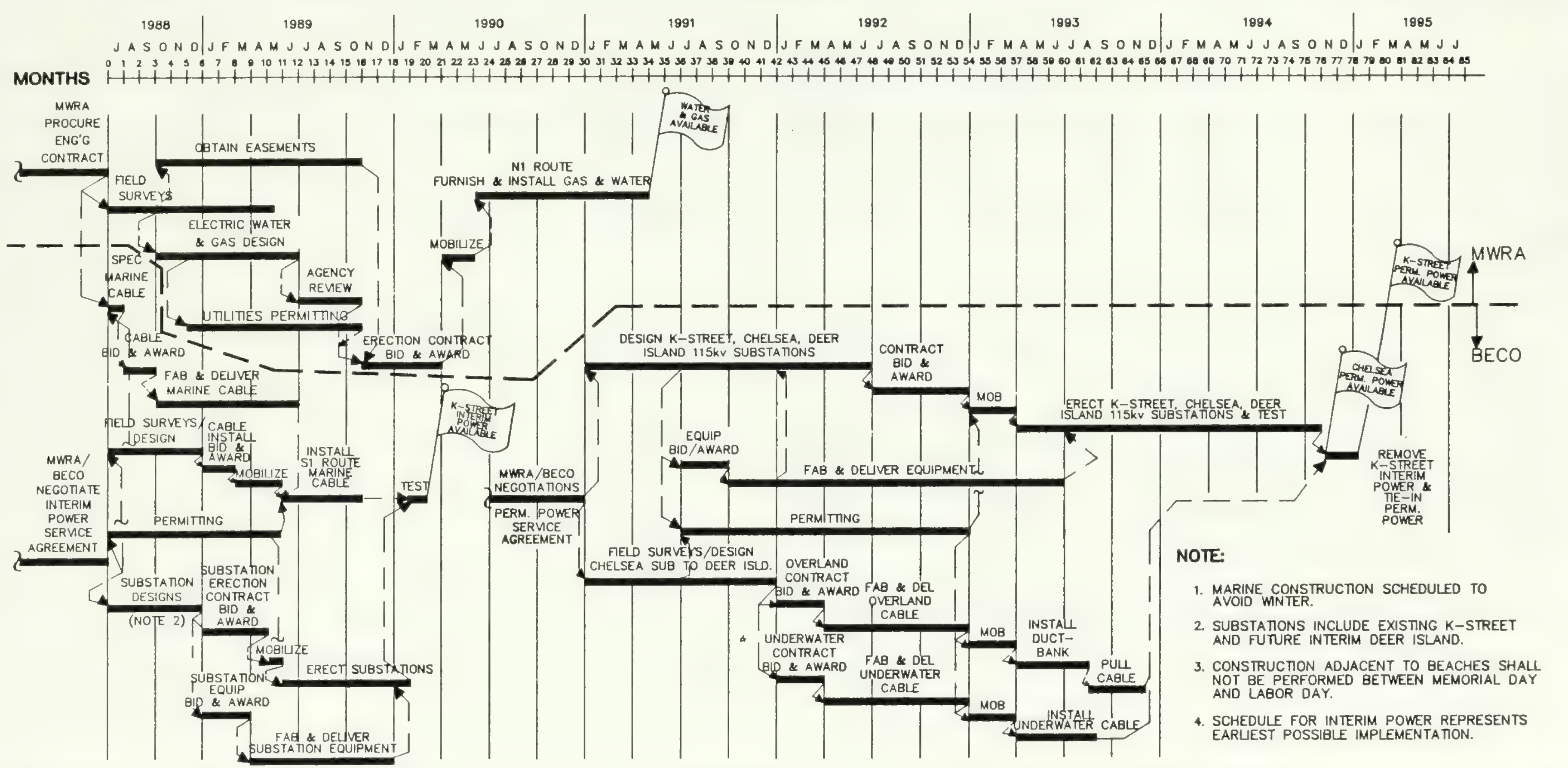
Therefore, the ability to implement the second alternative for permanent power according to schedule is rated moderate.

4.2 ENVIRONMENTAL EVALUATION OF ALTERNATIVES

Environmental criteria has been evaluated in terms of Land Resources, Traffic, Noise, Marine Resources and Marine Archaeology. Land Resources include land use, parks and recreational resources, terrestrial ecology, floodplains and wetlands, and historical and archaeological resources. Evaluation of these criterion in relation to each of the alternative routes is described in the following sections. Table 4.2-1 presents the results of the land resources alternatives evaluation.

4.2.1 LAND RESOURCES - LAND USE

Impacts to land use are rated as "minimal" for all of the alternative routes because there will be no permanent changes to existing land uses.



NOTE:

1. MARINE CONSTRUCTION SCHEDULED TO AVOID WINTER.
2. SUBSTATIONS INCLUDE EXISTING K-STREET AND FUTURE INTERIM DEER ISLAND.
3. CONSTRUCTION ADJACENT TO BEACHES SHALL NOT BE PERFORMED BETWEEN MEMORIAL DAY AND LABOR DAY.
4. SCHEDULE FOR INTERIM POWER REPRESENTS EARLIEST POSSIBLE IMPLEMENTATION.

MASSACHUSETTS WATER RESOURCES AUTHORITY

FIGURE 4.1.4–2
OFFSITE UTILITIES SCHEDULE
CHELSEA PERM. POWER ROUTE N2

MWRA_33
8–11–88

TABLE 4.2-1

LAND RESOURCES ALTERNATIVES EVALUATION

	Alternative							
Criteria	N-1	N-1A	N-1B	N-1C	N-1D	N-2	S-1	S-2
Land Use	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Parks and Recreational Areas	Moderate	Moderate	Moderate	Minimal	Moderate	Moderate	None	Moderate
Terrestrial[1] Ecology	Moderate	Moderate	Minimal	Minimal	Minimal	Moderate	Minimal	Moderate
Floodplains[2] and Wetlands	Moderate	Moderate	Minimal	Minimal	Moderate	Moderate	Moderate	Moderate
Historic and Archaeological	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Significant
Overall Rating	Moderate	Moderate	Moderate	Minimal	Moderate	Moderate	Moderate	Moderate

(1) Refer to Table 4.2.4-1
(2) Refer to Table 4.2.3-1

4.2.2 LAND RESOURCES - PARKS AND RECREATIONAL RESOURCES

Impacts to parks and recreational areas along each route are rated as minimal, moderate or significant. Minimal impacts reflect temporary inconveniences or nuisances to areas where the route passes the resource within the abutting street. Moderate impacts are also temporary, however, they occur within the boundaries of the resource. Significant impacts relate to permanent alterations or damage to the resource.

Route N-1

Impacts to parks and recreational areas along Route N-1 are rated as moderate due to the temporary disturbances associated with construction activities. Section 3.2 describes the parks and recreational areas that Route N-1 passes or crosses. This route passes four recreational areas and crosses one. Since no permanent changes to these areas will occur as a result of constructing utility lines along this route, impacts are judged to be moderate.

Route N-1A

Impacts to parks and recreational areas along Route N-1A are rated as moderate due to the temporary disturbances associated with construction activities. Section 3.2 describes the parks and recreational areas that Route N-1A passes by or crosses. This route passes three recreational areas and crosses one. Since no permanent changes to these areas will occur as a result of constructing utility lines along this route, impacts are judged to be moderate.

Route N-1B

Impacts to parks and recreational areas along Route N-1B are rated as moderate due to the temporary disturbances associated with construction activities. Section 3.2 describes the parks and recreational areas that Route N-1B passes by or crosses. This route passes eight recreational areas but does not cross any. Although no permanent changes to these areas will occur as a result of constructing utility lines along this route, impacts are judged to be moderate because the route passes eight parks or recreational areas.

Route N-1C

Impacts to parks and recreational areas along Route N-1C are rated as minimal due to the temporary disturbances associated with construction activities. Section 3.2 describes the parks and recreational areas that Route N-1C passes. This route passes five recreational areas but does not cross any. Since no permanent changes to these areas will occur as a result of constructing utility lines along this route, impacts are judged to be minimal.

Route N-1D

Impacts to parks and recreational areas along Route N-1D are rated as moderate due to the temporary disturbances associated with construction activities. Section 3.2 describes the parks and recreational areas that Route N-1D passes or crosses. This route passes three

recreational areas and crosses one. Since no permanent changes to these areas will occur as a result of constructing utility lines along this route, impacts are judged to be moderate.

Route N-2

Impacts to parks and recreational areas along Route N-2 are rated as moderate. Section 3.2 describes the parks and recreational areas that Route N-2 passes or crosses. This route passes one recreational area and crosses one. Although Route N-2 must be considered in combination with one of the N-1 routes, no permanent changes to these areas will occur and therefore impacts are judged to be moderate.

Route S-1

There will be no impacts to parks and recreational areas along Route S-1.

Route S-2

Impacts to parks and recreational areas along Route S-2 are rated as moderate due to the temporary disturbances associated with construction activities. Section 3.2 describes the parks and recreational areas that Route S-2 passes. This route passes two recreational areas and crosses one. Since no permanent changes to these areas will occur as a result of constructing utility lines along this route, impacts are judged to be moderate.

4.2.3 LAND RESOURCES - TERRESTRIAL ECOLOGY

Potable Water, Natural Gas and Permanent Power - Northern Routes

Proposed permanent power, gas and water routes N1, N-1A, N-1B, N-1C and N-1D are described in Section 3.1.1. For the most part, these routes follow existing roadways; thus, there will be little or no impact on local terrestrial ecological resources. Construction will take place within existing roadways and should not impact vegetation adjacent to the streets.

The Mill Creek crossing will utilize the existing bridge; thus, there should be no adverse impact on stream border or wetland habitats which may be associated with this water body. Overall, construction impacts should be minimal for those routes confined to roadways, as shown on Table 4.2.3-1.

Yirrell Beach will be affected by the N-1, N-1A and N-1D alternatives. Routes N-1 and N-1A will have a slightly greater impact than Route N-1D in terms of the overall amount of habitat disrupted. Route N-1D will utilize 4500 ft of the beach (about 1.5 acres) while routes N-1 and N-1A will necessitate disturbing 7100 ft (2.4 acres). In addition, these two routes will require the removal of the existing beach vegetation present at the southern tip of the beach. No unique, rare or biologically sensitive plants will be affected by this option. However, removal of beach vegetation, regardless of how common the species, is regarded as a moderately severe impact since beach vegetation is important for its ability to reduce erosion and stabilize soils.

TABLE 4.2.3-1

COMPARISON OF IMPACTS ON TERRESTRIAL ECOLOGICAL RESOURCES

RESOURCE	N-1	N-1A	N-1B	N-1C	N-1D	N-2	S-1	S-2
Disturbance of Vegetation	Moderate	Moderate	Minimal	Minimal	Minimal	Minimal	Minimal	Moderate
Impact to Intertidal Areas	None	None	None	None	None	Moderate	Minimal	Moderate
Impact to Beaches	Moderate	Moderate	None	None	Minimal	Moderate	None	None
Impact to Endangered/ Threatended Species	None	None	None	None	None	None	None	None
Overall Ranking	Moderate	Moderate	Minimal	Minimal	Minimal	Moderate	Minimal	Moderate

Overall, those power, water and gas alternative routes which confine themselves to existing roadways (e.g. N-1B and N-1C) are preferable to any of the alternatives which will disturb Yirrell Beach. Of those options which will impact Yirrell Beach, Route N-1D is preferred over routes N-1 and N-1A because of the reduced amount of habitat affected.

Permanent Power - Northern Route

The permanent power route alternative N-2 will have a much shorter overland portion than N-1, the majority of the route being submarine. Native and ornamental trees and plantings along existing roadways should not be adversely affected by construction within existing streets.

Construction activities along Route N-2 will take place in the Orient Heights Beach and intertidal area, as described in Section 4.2.8 under Marine Resources. Disturbance of the beach and intertidal zone presents a moderate potential for adverse impact, as shown on Table 4.2.3-1.

Interim and Permanent Power - Southern Routes

A comparison of the southern interim and permanent power route alternatives S-1 and S-2 indicates that S-1 will have a minimal impact on local terrestrial resources (Table 4.2.3.-1). S-1 will disrupt the intertidal area of the Fort Point Channel, but this area is heavily degraded, as described in Section 3.8.3, under Marine Resources, and therefore of minimal value.

Route S-2 has a longer overland potion and will ultimately disrupt the landscaped area and recent plantings adjacent to Fort Independence. It will also affect the intertidal area adjacent to the Sealand Terminal. This intertidal area is judged to be more valuable than that of the Fort Point Channel. Thus, disruption of these areas would result in a moderate potential for impact on local ecological resources.

Comparison of Potential Impacts

None of the alternatives for the northern utility supplies have a significant potential for adverse impact on terrestrial ecological resources. Impacts for route options N-1B and N-1C are judged to be minimal because they will follow existing roadways, and not impact beaches, wetlands or other ecological resources.

Options N-1 and N-1A, which would utilize Yirrell Beach, are judged to have a moderate potential for adverse impact due primarily to disruption of the beach area. Route N-1D has less overall potential for impact since no beach vegetation will be removed. Routes N-1 and N-1A will involve the removal of the vegetation present at the southern end of the beach. Beach vegetation, although scattered and limited in quantity, is considered valuable because of its soil-stabilizing qualities and ability to reduce erosion. Thus, disturbance of beach vegetation will have a potentially greater impact.

Impacts for Route N-2 are also judged to be moderate. Although the overland portion of this route is much shorter than the other routes, the submarine portion will necessitate work in the

Orient Heights Beach and intertidal area.

Of the two southern interim and permanent power routes, Route S-1 is preferred over Route S-2 since it has a shorter overland portion. In addition, Route S-2 will involve trenching in the area adjacent to Fort Independence between the fishing pier and the Sealand Terminal. This area has recently been restored as a harborview park and contains ornamental plantings and grassed areas.

4.2.4 LAND RESOURCES - WETLANDS AND FLOODPLAINS

Potable Water, Natural Gas and Permanent Power-Northern Routes

The proposed northern mixed utility routes do not have a significant potential for adverse impact on wetlands or floodplains. The majority of construction will take place in existing roadways.

As shown on Table 4.2.4-1, no impact to either tidal or freshwater wetlands is expected as a result of construction along any of the northern mixed utility routes. The Mill Creek crossing will utilize the existing bridge such that there will be no adverse impact to any wetlands associated with this water body.

With respect to floodplains, portions of all of the northern mixed utility routes are within areas designated as the 100-year floodplain. Thus, each route has essentially the same potential for impact. However, for the alternative routes N-1B and N-1C, minimal impact is predicted since no construction will occur within Yirrell Beach.

For the alternative route options N-1, N-1A and N-1D, disruption of Yirrell Beach will be necessary. Routes N-1 and N-1A will require more construction in the beach (e.g. disturb more beach habitat) than Route N-1D (2.4 versus 1.5 acres); thus, these two routes may be said to have a moderate potential for impact, while Route N-1D has a minimal potential for adverse impact.

Permanent Power-Northern Route

As previously discussed, the permanent power route from the north, Route N-2, is primarily a submarine route. Thus, construction of this route would occur within the floodplain. In addition, the intertidal areas associated with Orient Heights Beach and Deer Island will be disrupted as a result of the cable-embedding operations. Therefore, this alternative has a moderate potential for adverse impact.

Interim and Permanent Power-Southern Routes

The majority of alternative Route S-1 will be constructed within the floodplain, since, like Route N-2, this is essentially a submarine route. In addition, disruption of the intertidal habitat in the Reserved Channel and on Deer Island will result from cable-embedding operations.

TABLE 4.2.4-1

COMPARISON OF IMPACTS OF ALTERNATIVE ROUTES ON WETLANDS AND FLOODPLAINS

CRITERIA	N-1	N-1A	N-1B	N-1C	N-1D	N-2	S-1	S-2
Floodplain Construction								
In Roads	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
CrossCountry	Moderate	Moderate	Minimal	Minimal	Moderate	Moderate	Moderate	Moderate
Impacts to Tidal Wetlands	None	None	None	None	None	Moderate	Moderate	Moderate
Overall	Moderate	Moderate	Minimal	Minimal	Moderate	Moderate	Moderate	Moderate

Overall, the potential for adverse impact is considered to be moderate.

Alternative Route S-2 is approximately one-third shorter in terms of its submarine portion (2.5 versus 3.5 miles). Thus, less construction would have to occur within the floodplain. However, the intertidal area adjacent to Fort Independence and on Deer Island would be disrupted as a result of cable-embedding operations, so the overall impact to the floodplain would also be moderate.

4.2.5 LAND RESOURCES - HISTORIC AND ARCHAEOLOGICAL RESOURCES

Routes were evaluated for their potential impact on historic and archeological resources by applying the following criteria:

Significant Impact - In terms of historic resources, routes of potentially significant impact are considered to be those which will result in permanent damage to the building. This may be the case where the routes will pass close to buildings, possibly threatening their structural integrity by trenching and other construction impacts; or where trenching will disturb or require the removal of original building fabric. In terms of Section 106 of the National Historic Preservation Act (NHPA), "significant impacts" are considered adverse effects.

In terms of archaeological resources, impacts are generally high because of the fragile and systematic nature of archaeological resources. Any impact which completely modifies an archaeological site is considered significant due to the non-renewable nature of the sites.

Moderate Impact - In terms of historic resources, moderate impacts on buildings are those which will not threaten structural integrity, but will have such temporary impacts as traffic diversion, disruption of access, noise, dust and vibration during construction. Pavement will be cut with saws, not jackhammers, and thus construction impacts to buildings along the routes will not be severe. Since the utility supply lines will be buried for their entire length, no long-term negative effects are expected. In terms of Section 106 of NHPA, "moderate impacts" are not considered adverse.

Because no impact to an archeological site is temporary, only impact to a portion of a site may be considered a moderate impact.

Low Impact - In terms of historic resources, routes of low impact are those along which no significant impacts are anticipated.

Potable Water, Natural Gas and Permanent Power

Route N-1

Construction of the gas and water mains will remain in the streets and then travel along the beach in Winthrop. This route will have moderate impacts where it passes the Mary C. Burke School, the Battle of Chelsea Creek Site and the three sites on Winthrop Avenue in Revere.

Impacts on the Slade Spice Mill will also be moderate and temporary provided that the recommended mitigation measures described in Section 5.5 are followed.

There will be no impacts to archaeological resources at Mill Creek as the supply lines will be suspended from the bridge and not buried underground. At the Battle of Chelsea Creek site, the impact will be moderate. There will be no impacts at Sales Creek as the stream runs in a culvert, and the utility line will be placed in the roadway above the culvert. Impacts at the seawall site in Winthrop will be light because of the installation of the utility lines close to the seawall footings. At Shirley Point, the impact will be moderate since the route is not in the roadway.

Route N-1A

Historic and archaeological impacts along this route will be the same as for Route N-1.

Route N-1B

Impacts to historic resources will be the same as for Route N-1, with the following additions: The Revere Street-Shirley Street route will have a moderate and temporary impact where it passes the Deane Winthrop House, provided that the recommended mitigation measures described in Section 5.5 are followed. The Route will also have a moderate impact where it passes the Winthrop Yacht Club.

Impacts to archaeological resources will be the same as for Route N-1, except that there will be no impact at Shirley Point or at the seawall as the utility lines will run in the roadway.

Route N-1C

Impacts to historic resources will be the same as for Route N-1, with the following additions: Moderate impacts are anticipated at the UnionCongregational Church on Tewksbury Street and the Winthrop Yacht Club on Shirley Street.

Impacts to archaeological resources will be the same as Route N-1, except that there will be no impacts at Shirley Point as the utility lines will run in the roadway.

Route N-1D

Impacts to historic and archaeological resources will be the same as for Route N-1, except that there will be no impacts to Shirley Point as the utility lines will run in the roadway.

Permanent Power - Northern Route

Route N-2

There will be moderate impacts to all of the historic sites in East Boston identified in

Section 3.5 of this report. There will be no archaeological impact to the Chelsea Creek site because the power lines will be laid in an existing conduit under the river. At Orient Heights Beach, the impact will be moderate due to the short distance the route travels across the beach. This route, however, must be evaluated in conjunction with one of the N-1 routes as it will only carry power.

Interim and Permanent Power - Southern Routes

Route S-1

There will be no impacts to historical resources. Moderate impacts are expected to archaeological resources along the Reserved Channel.

Route S-2

Moderate impacts are expected for the historic sites and districts in South Boston along this route. Potentially significant impacts expected where the route passes the Castle Island area will depend on the actual alignment of the route through the property.

Archaeological impacts will be moderate at the Pleasure Bay Beach and significant at Fort Independence due to the proximity of the route to the original seawall.

Table 4.2-1 presents a matrix of the overall anticipated impact along each route using the criteria described at the beginning of this section.

4.2.6 TRAFFIC

Traffic impacts associated with the construction of the utility lines will generally be related to increased travel times, delays and traffic backups. For the purpose of comparing the alternative routes, the length of roadway affected along each route and the length of the route which, due to construction activities, will be restricted to less than two lanes of traffic are identified. This information is summarized in Table 4.2.6-1. Following is a description of the effects of construction on each route.

Route N-1

Route N-1 will affect two roadways in Chelsea; Broadway and Eastern Avenue. Both roadways are between 37-ft and 53-ft in width and at least three lanes of traffic can be maintained along each during construction.

Two roadways will be affected in Revere: Winthrop Avenue and Revere Beach Parkway. Revere Beach Parkway is the main east-west arterial through Revere and supports three lanes of traffic in each direction. The north-south segment south of Winthrop Parkway is part of the north access route to Winthrop. Only one direction of traffic will be affected by construction on

TABLE 4.2.6-1

COMPARISON OF TRAFFIC CRITERIA FOR ALTERNATIVE ROUTES

Route	Length of Construction In Road(Ft)	Length of Route With Less than two Lanes Open Around Construction (Ft)
N-1	24,200	3,900
N-1A	25,200	2,100
N-1B	32,700	12,700
N-1C	32,200	8,900
N-1D	27,900	3,400
N-2	10,700	0
S-1	0	0
S-2	8,700	0

Revere Beach Parkway, and at least two lanes of traffic can be supported on all segments of Winthrop Avenue.

The affected roadways in Winthrop along Route N-1 are Revere Street, Crest Avenue and Winthrop Shore Drive. Revere Street, north of Crest Avenue, is one of only two access routes into Winthrop. Two lanes of traffic can be maintained along Revere Street during construction. Crest Avenue is fairly narrow and is bordered by local commercial businesses and curbside parking is allowed. One lane could remain open during construction along Crest Avenue as long as curbside parking was not allowed for this period of time. Winthrop Shore Drive abuts Winthrop Beach and is approximately 36 feet wide. Construction should be avoided during the summer months when traffic and parking along the road is heavy. Two lanes of traffic could be maintained during construction in the off-season.

The length of construction within the roadways is approximately 24,200 feet. The length of the route having less than two lanes open around the construction area is approximately 3,900 feet.

The remainder of Route N-1 is cross-country and construction would not create any traffic impacts.

Route N-1A

Route N-1A would affect the same roadways as Route N-1 with the exception of Crest Avenue. Route N-1A avoids Crest Avenue by continuing along Revere Street and then crossing over to Winthrop Shore Drive via Locust Street. Locust Street is a small residential street with a cartway width of approximately 26 feet. One lane would remain open during construction to allow residents to travel to and from their homes. By traveling along Locust Street, this route will avoid disrupting the commercial and traffic activity along Crest Avenue.

The length of construction within the roadway is approximately 25,200 feet. The length of the route having less than two lanes open around the construction area is approximately 2,100 feet.

Like Route N-1, this route travels cross-country south of Winthrop Shore Drive and will not create any traffic impacts.

Route N-1B

Route N-1B will affect the same roadways as Route N-1 as far as Crest Avenue. From there it continues to Shirley Street, Veterans Road and a very short segment of Washington Avenue, to Shirley Street. These roadways are part of the designated truck route through Winthrop to Deer Island.

At least one lane can be maintained for routing vehicles around utility line construction for the majority of affected roadways. Traffic on these roads is relatively light; bidirectional traffic could be accommodated provided that flagworkers are stationed at each end of the construction zone to assist in safe, smooth traffic routing.

Tafts Avenue between Shirley Street and the beginning of the Deer Island causeway seawall is too narrow for even one traffic lane to be kept free should electric power, gas and water service lines be constructed in a common trench. Vehicles will be detoured around the construction by using adjacent and equally narrow residential roadways. Tafts Avenue is one-way north between Shirley Street and Elliot Street. Only southbound traffic will be precluded from this roadway section. Traffic in both directions will be prevented from using Tafts Avenue between Elliot Street and the beginning of the Deer Island causeway seawall located in the Adams Street vicinity.

Closing Tafts Avenue will result in seriously disrupting traffic to Deer Island for at least 7 construction days if all three service lines are constructed using the same trench. As described in Appendix K of Volume III of the STFP, approximately 289 to 336 worker vehicles and 65 to 133 trucks will need access to Deer Island for the secondary treatment facilities construction. However, two utility lines (water and gas) could be constructed at another time. Constructing utility lines in this manner would allow at least one lane of traffic to be maintained on Tafts Avenue. However, this would still cause considerable disruption to construction activities on Deer Island.

The length of construction within the roadway is approximately 32,700 feet. The length of the route having less than two lanes open around the construction area is approximately 12,700 feet.

Route N-1C

Route N-1C will affect the same roadways as Route N-1. It then travels along Tewksbury Street which is a quiet residential street approximately 550 ft in length and perpendicular to Winthrop Shore Drive. No lanes along Tewksbury Street will be available for vehicle passage during construction. From Tewksbury Street the route will follow the same roads as Route N-1B to Deer Island, creating similar impacts to traffic.

The length of construction within the roadway is approximately 32,200 feet. The length of the route having less than two lanes open around the construction area is approximately 8,900 feet.

Route N-1D

Route N-1D will affect the same roads as Route N-1A. From Winthrop Shore Drive south, this route is off the road and follows the beaches as far as Adams Street. From there it travels along Adams Street to Shirley Street where it follows the same roads as Routes N-1B and N-1C to Deer Island, creating similar impacts to traffic.

The length of construction within the roadway is approximately 27,900 feet. The length of the route having less than two lanes open around the construction area is approximately 3,400 feet.

Route N-2

Route N-2 is an alternate for bringing permanent power to Deer Island from Chelsea Substation. Two roadways will be affected in Chelsea by Route N-2: Eastern Avenue and Marginal Street. At least three lanes of traffic can be maintained along each roadway.

Four roadways are affected by roadway construction in East Boston: Shelby Street, Saratoga Street, Neptune Street and Bennington Street. Shelby Street is a small one-way residential street resulting in minimal traffic impact. Saratoga Street and Neptune Street are also relatively minor roadways while Bennington Street is a southwest-northeast arterial between East Boston and southwest Revere. At least five lanes of traffic could be maintained along Bennington Street if parking is disallowed. The affected Neptune Street and Saratoga Street segments are wide and can respectively support four to six lanes of traffic during construction.

From Bennington Street, the route will cross Orient Heights Beach and Boston Harbor to Deer Island. Route N-2 must be considered in conjunction with one of the N-1 routes since Route N-2 will only carry permanent power.

The length of construction within the roadway is approximately 10,700 feet. None of Route N-2 will have fewer than two lanes open around the construction area.

Route S-1

Route S-1 will not have any impact on roadway traffic as it does not follow any roadways.

Route S-2

Three roadways in South Boston will be affected by Route S-2. These are William J. Day Boulevard, Broadway, and K Street. William J. Day Boulevard is an ocean view drive to Fort Independence that provides public access to Pleasure Bay. As a result, there is heavy use of parking wherever it is allowed. Broadway and K Street are bordered primarily by high density residential housing. Parking is also heavily used on these streets.

Bidirectional traffic can be maintained on all three roadways; at least three lanes are available on both Broadway and William J. Day Boulevard, and two lanes on K Street. Peak hourly traffic volumes are respectively 900, 1600 and 200 vehicles per hour.

The length of construction within the roadway is approximately 8,700 feet. None of Route S-2 will have fewer than two lanes open around the construction area.

The remainder of the route will be underwater across Boston Harbor.

4.2.7 NOISE

Sound level predictions were made for both the on-land and marine construction activities associated with the utility supplies. These predictions were based upon the type of equipemnt which would likely be used for these operations. Where more than one operation is to be performed sequentially, such as excavation in a roadway, backfilling and resurfacing, the sound levels were estimated for each operation.

Typical equipment for the excavation, installation of piping and/or electrical cable and ductbank sections, backfill and grading operations include a backhoe, trucks, air compressors, welders and front-end loader. The compaction and paving operations include trucks, a paving machine, and rollers.

The distance from on-land utility supply construction to the nearest noise sensitive receptors is a minimum of approximately 15 to 20 feet for houses very close to the street. A distance of 50 ft. was used as the reference distance for the presentation of results to allow for receptors located farther back from the street. The projected levels could be up to 10 dBA louder where residences are extremely close to the street.

The sound levels expected for the submarine cable laying operation were made based on sound level information provided by contractors responsible for using the jetting-embedment submarine cable equipment, and from other sources. The primary noise sources associated with operation of this equipment include the barge anchor tug drive, the main hydraulic pump drives, the deck crane, the diesel winch and air compressors. The equipment sound levels were summed based upon the percent of time each equipment item is expected to operate. The far field sound level was subsequently calculated, based on the distance to the nearest residence.

The potential noise impact for each of the alternative routes and construction operations is a function of the projected sound levels, the speed at which the construction operation passes through an area, and the potential sensitivity of the area to noise, i.e., residential and commercial areas would have a higher sensitivity to noise than industrial areas. Table 4.2.7-1 summarizes and compares the projected construction noise impacts for each of the alternative utility supply routes, using these criteria.

The projected sound levels shown in the table are the maximum values expected for the construction activities appropriate to each alternative route. Attenuation of construction noise, which would be expected due to barrier effects from intervening buildings or structures, are not included in these projections.

The rate of movement indicates how fast the construction activity moves along the route. Each time the distance is doubled from any receptor, the projected sound level drops an additional 6 dBA. As the paving operation moves away from an individual residence, the sound level will drop off from the projected maximum value by 10, 15 and 20 dBA on days 1, 2 and 3, respectively.

Table 4.2.7-1 indicates that for the northern utility route alternatives which will provide electrical power, natural gas and potable water in a common route, there are essentially no significant differences in potential noise impacts to commercial and residential areas. However, it should be noted that the route alternatives N-1A, N-1B, and N-1D avoid potential noise impact to the Dalrymple Elementary School in Winthrop, located near the corner of Grovers Street and Crest Avenue.

Route N-2, which would provide only electrical power to Deer Island from BECo's Chelsea Substation, has much fewer commercial and residential areas which would be affected in comparison with the other northern route alternates. However, Route N-2 must be constructed in addition to one of the other northern routes which would carry natural gas and potable water; therefore, the cumulative noise impacts associated with Route N-2 are much greater than the other alternative routes.

Of the two southern electrical power routes, S-1 is clearly superior to Route S-2: Route S-1 has minimum noise impact associated with the submarine cable activities while Route S-2 not only has a greater noise impact resulting from the submarine cable construction due to its proximity to the Castle Island recreational area, but it also has a high impact to residential areas in South Boston.

4.2.8 MARINE RESOURCES

The proposed water, power and gas routes from the north (Routes N-1, N-1A, N-1B, N-1C, and N-1D) are overland routes which will have essentially no adverse impact on marine resources in the local area. For the most part, these northern routes will follow existing roadways. However, the N-1, N-1A and N-1D options involve trenching under the seawall around Winthrop Head and along Yirrell Beach on the seaward side. This necessitates the disturbance of the sand/cobble beach above mean high water. However, there will be little or no impact on local marine resources since work will be conducted above the intertidal zone. The beach will be restored to its original condition upon completion of construction activities.

The width of the trench will depend on the utilities being routed (e.g., natural gas, potable water, power) and will vary from about 11 to 15 feet wide. For option N-1D, about 1.5 acres of beach will be affected. However, no vegetation or other native biological communities will be disturbed.

For Routes N-1 and N-1A, about 2.4 acres of beach habitat will be disturbed. Vegetation which is present at the southern end of the the beach between the end of the seawall and Deer Island will be removed during construction. As discussed in Sections 3.3.1 and 3.8.1, no threatened, endangered or otherwise important flora or fauna are present in this area. However, disturbance of this community presents a moderate impact since beach vegetation is valuable for its ability to reduce erosion and stabilize soils.

COMPARISON OF CONSTRUCTION NOISE IMPACTS FOR ALTERNATIVE ROUTES

Criteria	Route N-1	Route N-1A	Route N-1B	Route N-1C	Route N-1D	Route N-2	Route S-1	Route S-2
Maximum Sound Level:(1)								
During Excavation	84	84	84	84	84	84	NA(2)	84
During Paving	86	86	86	86	86	86	NA	86
Submarine Cable	NA	NA	NA	NA	NA	71	<60	71
Construction Rate in feet/day:								
Excavation	125	125	125	125	125	125	NA	125
Paving	1500	1500	1500	1500	1500	1500	NA	1500
Submarine Cable	NA	NA	NA	NA	NA	100-500	100-500	100-500
Total Length of Affected Residential/Commercial Areas Along Route, Feet	32,300	33,000	33,700	33,200	33,400	6,700	0.0	8,100

(1) Maximum project sound levels are based on distance between the construction activities and the nearest commercial or residential area receptor as follows:

On-land construction	50 feet
Submarine cable (N-2, S-2)	300 feet
Submarine cable (S-1)	>1000 feet

(2) NA = Not Affected

All of the overland routes will involve a river/stream crossing (e.g., Mill Creek); however, this will be accomplished by utilizing the existing bridge. Therefore, no wetlands or stream habitat will be disturbed by these options.

Overall, the effects of construction of these routes on marine resources will be minimal.

The proposed permanent power route Route N-2 from the BECo Chelsea Substation to the Substation on Deer Island includes both overland and underwater portions as shown on Figure 2.4.3-1. The overland portion follows existing roadways to Chelsea River from the substation. The Chelsea River crossing will be accomplished by running the power cables from and to manholes on either side of the river, utilizing existing submarine conduits. No wetland or other important stream border habitat will be disturbed.

The submarine portion of the proposed permanent power Route N-2 begins at Orient Heights Beach and follows the navigation channel through Winthrop Harbor to Deer Island. The submarine cable will be embedded using a jetting technique. A description of the cable laying device and details of its operation are provided in Section 2.5. As previously discussed, the jetting technique provides an environmentally acceptable method for installing the power cables with the least adverse impact to local marine resources.

Impacts associated with installation of the submarine cable include turbidity, resuspension of bottom sediments containing contaminants, and loss of benthic habitat as shown in Table 4.2.8-1. Overall, however, construction of this submarine route is expected to have a moderate potential for impact on marine resources, due to the potential but temporary release of contaminants to the water column.

Comparison of Potential Impacts

In comparing the six northern routes N-1, N-1A, N-1B, N-1C, N-1D and N-2 for water, gas and electric utilities, it is obvious that the overland routes have essentially no impact on marine resources when compared to the submarine route N-2 (Table 4.2.8-1). These overland routes are therefore preferable from the standpoint of protecting marine resources.

The impacts associated with the cable-embedding technique, however, are minimal when compared to other construction methods such as dredging. There will be minimal loss of benthic habitat, minimal disturbance of intertidal areas and beaches, minimal changes in water quality, and minimal turbidity. However, because of the contaminants contained within the sediments, particularly in Winthrop Bay, resuspension of these sediments is predicted to have a moderate potential for adverse impact on local marine biota. Overall, the potential for adverse impact as a result of submarine cable-embedding is considered to be moderate.

The interim and permanent southern power routes, S-1 and S-2 include both overland and underwater portions as shown on Figures 2.4.4-1 and 2.4.4-2. Both routes originate from BECo's K-Street Substation. For S-1, the power cable traverses an abandoned open field behind the

TABLE 4.2.8-1

COMPARISON OF IMPACTS OF ALTERNATIVE ROUTES ON MARINE RESOURCES

Construction Impacts	Alternative Utility Supply Routes							
on Marine Resources	N1	N-1A	N-1B	N-1C	N-1D	N-2	S-1	S-2
Loss of Benthic	NA	NA	NA	NA	NA	Minimal	Minimal	Minimal
Disturbance to Intertidal Areas	None	None	None	None	None	Minimal	Minimal	Minimal
Impacts to Shoreline/ Beaches	Moderate	Moderate	None	None	Minimal	Minimal	Minimal	Minimal
Release of Contaminants from Sediment Resuspension	NA	NA	NA	NA	NA	Moderate	Moderate	Minimal
Impacts from Turbidity	NA	NA	NA	NA	NA	Minimal	Minimal	Minimal
Water Quality Changes	NA	NA	NA	NA	NA	Minimal	Minimal	Minimal
Effects on Spawning/Nursery Habitat for Finfish	NA	NA	NA	NA	NA	Minimal	Minimal	Minimal
Effects on Endangered Species	None	None	None	None	None	None	None	None
Summary of Impacts	Moderate	Moderate	None	None	Minimal	Moderate	Moderate	Minimal

NOTE: NA = Not Applicable

substation and enters the Reserved Channel west of the Summer Street Bridge, necessitating the disruption of the intertidal habitat in the area. The submarine portion of the route follows the Reserved Channel across the Harbor to Deer Island.

The overland portion of S-2 follows K Street to East Broadway, to Day Boulevard to Fort Independence (Castle Island), following existing roadways. Thus, there will be no adverse impact on marine resources for this portion of the route. The submarine portion of S-2 originates at Castle Island near the SeaLand Terminal, necessitating disruption of the intertidal community adjacent to the SeaLand Terminal near the McCorckle Fishing Pier.

Impacts associated with installation of the submarine cable in either S-1 or S-2 are essentially similar and include disruption of habitat, turbidity and resuspension of toxic materials. Route S-1, because of the need to traverse the Reserved Channel, has a moderate potential for adverse impact to local species due to resuspension of the contaminated sediments within the channel (Table 4.2.8-1). In addition, because of its longer submarine portion (3.5 versus 2.5 miles), S-1 will have a greater overall impact on marine resources (e.g., the amount of habitat disrupted, the duration of construction, and associated turbidity and resuspension of sediments).

Impacts associated with construction of Route S-2 are judged to be minimal.

4.2.9 MARINE ARCHAEOLOGY

None of the northern mixed utility routes (Routes N-1, N-1A, N-1B, N-1C, and N-1C) will impact potential marine archaeological resources.

Route N-2 crosses Boston Harbor between Logan Airport and Revere and Withrop as shown on Figure 2.4.3-1; Route S-1 crosses the Reserved Channel and Boston Harbor as shown on Figure 2.4.4-1; and Route S-2 crosses Boston Harbor from Castle Island as shown on Figure 2.4.4-2. As described in Section 3.9, there are no identified marine archaeological resources along these routes.

The extensive dredging and construction within the harbor from the late nineteenth century to the present further suggests that if wrecksites are found, their condition will be unlikely to warrant extensive scientific inquiry. In addition, the overall effects of inner harbor bottom characteristics and conditions are generally summarized as extremely unfavorable for the preservation of any unidentified submerged cultural resources. Therefore, these routes are rated as "excellent" as they relate to possible impacts to marine archaeological resources.

4.3 INSTITUTIONAL EVALUATION OF ALTERNATIVES

This section evaluates the utility supply route alternatives using the criteria defined in Section 2.6. The utility supply route alternatives are broken down into two groups: Northern Routes and Southern Routes. The group of Northern Routes includes all alternatives which provide water, gas and permanent power to Deer Island from locations to the north of Deer

Island; the Southern Routes identify alternatives for providing permanent electrical power from BECo's K-Street Substation in the south via submarine routes. Institutional criteria include permitting, external coordination requirements, internal coordination requirements, and demand for unique or scarce construction resources.

The permitting requirements for using any of the permanent power routes as an interim power supply are the same as those indicated for the permanent power route.

The results of the institutional evaluation of alternatives are summarized in Table 4.3-1.

4.3.1 PERMITTING

Northern Routes

All of the northern utility supply route alternatives i.e., N-1, N-1A through N-1D and N-2, involve overland construction activities in roadways, construction within 10 feet of the 100 year floodplain, in "historic" tideland, in areas proximate to historic/archaeological resources; and require review/approval by the Energy Facilities Siting Council. The permits/approvals required for all of these routes, and the responsible agency, are as follows:

- Section 106 Review - Massachusetts Historical Commission (MHC)
- Coastal Zone Management (CZM) Consistency Review
- Chapter 91 Waterways License (DEQE)
- Wetlands Order of Conditions (City of Boston, City of Revere and Town of Winthrop)
- Road Opening Permits (MDC, DPW)
- Energy Facilities Siting Council

The permitting requirements for Routes N-1 and N-1A through N-1D are similar, and are judged to be "moderate."

Route N-2 will require all of the above permitting activities and, in addition, will also require a Section 10 Permit from the U.S. Army Corps of Engineers (COE) for construction in a navigable waterway and notification for Private Aid to Navigation from the U.S. Coast Guard. Since, Route N-2, as an alternative permanent power supply route, must be implemented in addition to the route selected for supplying potable water and natural gas, it more than doubles the permitting requirements which otherwise could be met by using a single, multiple utility supply route from the north. Therefore, relative to all other alternative northern utility supply routes, the permitting requirements for route N-2 are judged to be "extensive."

TABLE 4.3-1

INSTITUTIONAL EVALUATION OF ALTERNATIVES

	Alternative			
Institutional Criteria	N-1, N-1A through N-1B	N-2	S-1	S-2
Permitting	Moderate	Extensive	Moderate	Moderate
External Coordination Requirements	Moderate	Extensive	Moderate	Extensive
Internal Coordination Requirements	Extensive	Extensive	Moderate	Moderate
Demand for Unique or Scarce Const. Resources	Moderate	Difficult	Difficult	Difficult

Permanent Power - Southern Routes

As alternative routes for supplying either permanent or interim electrical power to Deer Island from BECo's K-Street Substation, both Routes S-1 and S-2 have the same permitting requirements indicated previously for Route N-2. However, unlike Route N-2, either of the southern permanent power supply routes will be permitted independently of the other utility supplies. The permitting requirements for both S-1 and S-2 are judged to be "moderate."

4.3.2 EXTERNAL COORDINATION REQUIREMENTS

The external coordination requirements for all alternatives are extensive, in view of the number of agencies required for permitting reviews and approval, and considering the need for close coordination with both BECo and Boston Gas. However, since the relative amount of coordination varies with each alternative, the characterization of external coordination requirements for each of the alternatives has been adjusted to allow resolution of the differences between each alternative.

Northern Routes

Of the northern utility supply route alternatives, Route N-2 will require the greatest degree of external coordination since it involves more than doubling the permitting activities associated with the other northern route alternatives, which provide all requisite utilities in a common route. Therefore, for comparative purposes, the external coordination requirements for route N-2 are rated as "extensive;" the external coordination requirements for the other northern utility supply routes are rated as "moderate."

Permanent Power - Southern Routes

The external coordination requirements for Route S-2 are considerably greater than for the S-1 alternative since Route S-2 entails roadway construction and construction within the Castle Island recreational area. The external coordination requirements for Routes S-1 and S-2 are rated as "moderate" and "extensive," respectively.

4.3.3 INTERNAL COORDINATION REQUIREMENTS

Northern Routes

The northern utility supply alternative Routes N-1 and N-1A through N-1D are rated equal in their requirements for internal coordination. All alternatives will require an "extensive" degree of coordination with other MWRA projects and between the MWRA Engineering, Project Management Unit, and Water Supply divisions. While Route N-2

alone will have only "moderate" internal coordination requirements, it will have to be implemented in addition to one of the water/gas routes, N-1A through N-1D, therefore, Route N-2 offers no advantage to minimizing the overall internal coordination requirements. For this reason, Route N-2 is rated "extensive" for internal coordination requirements.

PERMANENT POWER - SOUTHERN ROUTES

Both of the southern power route alternatives have been rated as having "moderate" internal coordination requirements since implementation of either route will be largely the responsibility of BECo. Internal coordination requirements for these alternatives are primarily associated with the construction of a switchyard on Deer Island.

4.3.4 DEMAND FOR UNIQUE OR SCARCE CONSTRUCTION RESOURCES

Northern Routes

The alternative northern utility supply Routes N-1 and N-1A through N-1D are all rated as "moderate" in their demand for unique or scarce construction resources. Each of these alternatives involves conventional construction activities and resources to a similar degree.

Route N-2, however, must be constructed in addition to a water/gas route and therefore duplicates the construction resources which must be employed. In addition, implementation of Route N-2 requires specialized equipment for the jetting-embedment installation of the submarine power cables. Route N-2 has, therefore, been rated as "difficult" in its potential demand for unique or scarce construction resources.

Permanent Power - Southern Routes

Both of the southern power routes are rated as "difficult" for their potential demand for unique or scarce construction resources since both alternatives employ the Jetting-embedment installation technique for the submarine power cable.

4.4 SUMMARY

The utility supplies which must be provided to support the construction and operation of the Deer Island wastewater treatment facilities are as follows: 1) two permanent electrical supplies from independent sources, i.e., BECo's Chelsea Substation in Chelsea and BECo's K-Street Substation in South Boston; 2) an interim electrical supply having an in-service date in 1990; and 3) permanent water and gas supplies from sources located to the north of Deer Island.

Eight alternative utility routes have been evaluated in detail: five alternative routes (i.e., N-1 and N-1A through N-1D) provide electrical power, water, and gas (or water and gas only) utility supplies in a common route to Deer Island from sources to the north; two alternative routes (i.e., S-1 and S-2) provide electrical power from BECo's K-Street Substation to the south; and one alternative (i.e., N-2) provides electrical power only from the north. The evaluation criteria used in this analysis address technical, cost, environmental, and institutional considerations.

Northern Routes

Route N-1A, carrying permanent electrical power, water, and gas in a common route, is recommended as the northern utility supply route to Deer Island, based on the evaluations described herein.

Comparisons of the five combined utility alternative northern routes on the basis of capital cost, technical criteria including reliability, constructibility, and timely implementation, and institutional criteria indicate that there are no significant differences among these routes, given the conceptual-level of engineering detail in this evaluation. During the detailed engineering phase of this project's implementation, it will be possible to achieve a greater degree of resolution of the differences among the northern alternatives. At this time, however, it is expected that significant differences among these routes will not be obvious: all five routes offer high reliability, normal constructibility conditions, and a moderate potential for timely implementation; cost differences among the routes are less than seven percent; all have moderate permitting requirements; and all require extensive internal coordination for their execution.

Major differences between the five combined northern routes are also not readily apparent with respect to environmental criteria, which are summarized in Table 4.4-1. The selection of Route N-1A is essentially based on its desirability with respect to diminished traffic impacts relative to all other routes. Route N-1A also avoids any cumulative traffic impacts to the truck route used by Deer Island construction, operation and maintenance vehicles. In addition, Route N-1A avoids construction in areas adjacent to schools, and minimizes the amount of construction in commercial/residential areas. While the recommended route does provide minimal impacts to beach areas in Winthrop, these impacts are temporary and can be mitigated to acceptable levels.

Route N-2, which would provide only permanent electrical power from BECo's Chelsea Station, was rejected since it offers no advantages with respect to implementation schedule. With respect to all other criteria except reliability, Route N-2 significantly increases costs, permitting requirements, environmental impacts, etc., since it would need to be constructed in addition to a northern, overland route carrying water and gas.

TABLE 4.4-1

ENVIRONMENTAL EVALUATION OF ALTERNATIVES

Environmental Criteria	Criterion	Alternatives							
		N-1	N-1A	N-1B	N-1C	N-1D	N-2	S-1	S-2
Land Resources	Overall rating[1]	Moderate	Moderate	Moderate	Minimal	Moderate	Moderate	Moderate	Moderate
Traffic	Length of construction in road (ft)	24,200	25,200	32,700	32,200	27,900	10,700	0	8,700
	Length of route with less than two lanes open around construction[2]	3,900	2,100	12,700	8,900	3,400	0	0	0
Noise Control	Total length of affected Res/Com areas along Route in ft[3]	32,300	33,000	33,700	33,200	33,400	6,700	0	8,100
Marine Resources	Overall rating[4]	Moderate	Moderate	None	None	Minimal	Moderate	Moderate	Minimal
Marine Archaeology	Overall rating	N/A	N/A	N/A	N/A	N/A	Excellent	Excellent	Excellent

(1) Refer to Table 4.2-1
(2) Refer to Table 4.2.6-1
(3) Refer to Table 4.2.7-1
(4) Refer to Table 4.2.8-1

Interim Power

Route S-1, transmitting electrical power from BECo's K-Street Substation to Deer Island via a submarine cable, was selected as the interim power supply route, since it can be implemented in 1990; this route will also provide the primary source of permanent power from the north. All of the northern, overland utility route alternatives were determined to have an interim electrical power in-service date in the Spring of 1991; Route N-2 also has no schedule advantage over the selected route.

Southern Route for Permanent Power

Implementation of the alternative Route S-2 will entail temporary disruption to the community in South Boston, associated with noise and traffic impacts. The recommended Route S-1 virtually eliminates land-based impacts to the community. While implementation of Route S-1 will involve temporary impacts to the marine environment resources in the Reserved Channel, these impacts are minimal and are mitigated through the use of the jetting-embedment cable technique.

With respect to the comparative capital costs, institutional and technical criteria, both routes S-1 and S-2 are nearly identical.

5.0 RECOMMENDED PLAN

5.1 DESCRIPTION

The recommended plan to bring offsite utilities to Deer Island to support construction and operations of the secondary treatment plant consists of the following:

- Interim electrical power from BECo's K-Street Substation in South Boston, via Route S-1; operational in 1990; and rated at 20 MW.

- Water from MWRA's Meter 41 located at the Winthrop/Revere town line via Route N-1A and available in 1991.

- Gas from the Boston Gas Company supply on Railroad Street in Revere, via Route N-1A, and installed concurrently with water.

- Permanent electrical power from the K-Street Substation using the cable and transformer installed for interim power; operational by January, 1995; and rated at 70 MW.

- Permanent electrical power from BECo's Chelsea Substation, via Route N-1A; operational by January, 1995; and rated at 70 MW.

Implementation of interim electrical power is critical to support construction of the Deer Island Secondary Treatment Facilities. Therefore, in the event the recommended K-Street service falls behind schedule, a contingency plan is recommended. The contingency plan is to concurrently bring interim power from the Chelsea Substation. The first cable installed would serve as the interim power. The other cable would remain disconnected until needed for permanent power. The decision on the need to implement this contingency plan should be made in January, 1989.

5.1.1 INTERIM AND PERMANENT POWER FROM K STREET

An interim source of electrical power rated at 20 MW will be provided by BECo from its K-Street Substation. The K-Street Substation (BECo Station No. 385) is an existing 115 kV substation. It is normally fed directly from BECo's adjacent two-unit New Boston Power Station. Each generating unit at New Boston is nominally rated at 380 MW. The interim power source will be a dedicated submarine transmission line feeding directly from the K-Street Substation to Deer Island. It will be buried along its entire route.

The K-Street Substation will be modified to accommodate the new circuit. The new circuit will consist of three separate cables. Since the K-Street substation will also serve as one of the two sources of 115 kV permanent power, the cables will be sized to handle both the interim and the permanent electrical load. Each oil-filled cable is approximately 4 inches in diameter and

is specially designed for submarine installation, including steel armoring jacket.

The cables will leave the K-Street Substation buried in a trench and follow Route S-1 (See Figure 5.1.1-1). Along the underwater portion of the route, the cables will be embedded in a single narrow trench (less than 2.5 feet wide) to provide protection from potential anchor dragging accidents. Required embedment depths are shallow in rock (10 ft$\pm$) and deep in sediment (up to 15 to 25 feet$\pm$). Also, the embedment depth through the Reserved Channel and across the main shipping channel will be coordinated with the U.S. Army Corps of Engineers to allow for its future dredging plans.

The cables will terminate at Deer Island on the high voltage side of a 115/13.8 kV transformer. The transformer will be located in the electrical substation area (see Secondary Treatment Facilities Plan, Volume, III, Treatment Plant, Figure 11.1.3-1, "Recommended Dear Island Facilities," Item 39). The transformer and any required metering equipment will be located such that it will not interfere with the construction of the future new Deer Island Gas Insulated (SF-6) Substation, needed in 1994 to accommodate the two future sources of permanent power. MWRA will pick up the power on the low voltage side and provide the required 13.8 kV switchgear and distribution. The transformer, like the cable, will be sized for both the interim and the permanent electrical load.

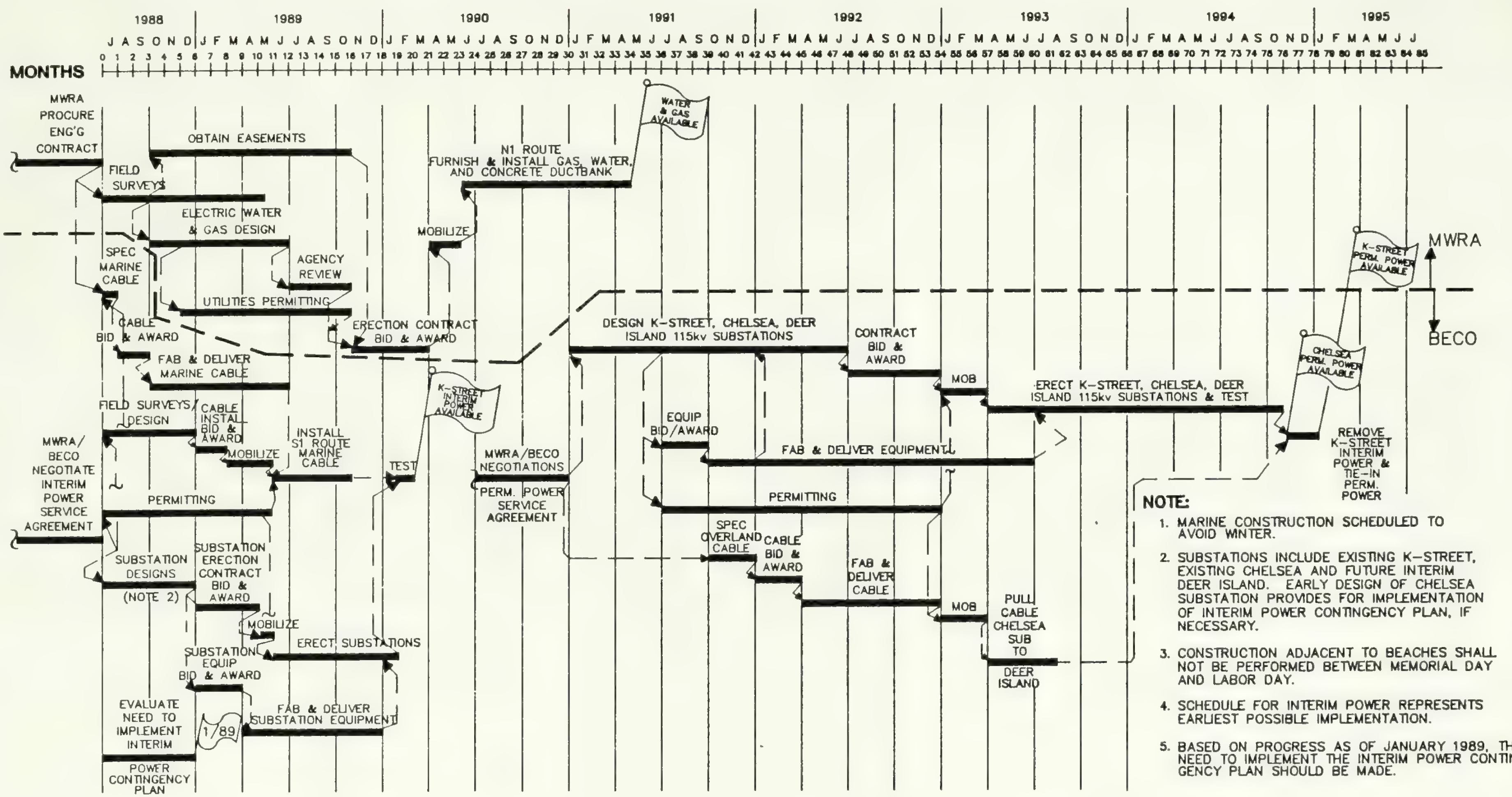
This interim supply will provide power to Deer Island until late 1994, at which time the permanent source of power from BECo's Chelsea Substation will be energized through the new SF-6 Deer Island Substation (see Figure 5.1.1-2). At that time, the interim supply will be disconnected to make the permanent tie-in from K-Street. This will require terminating the cable and relocating the interim transformer at the new SF-6 Deer Island Substation.

As shown on Figure 5.1.1-2, the scheduled in-service date for interim power is March, 1990. This is an optimistic schedule which may be attainable under ideal circumstances. To accomplish this, it will be necessary for MWRA to authorize BECo to proceed by July 1, 1988; engineering field surveys to support design and permitting must begin this summer and be completed in 1988; permitting must be handled expeditiously by the regulatory agencies; cable must be ordered in the fall of 1988; and no manufacturing or installation shortfalls can be tolerated. If any of the above fail to occur, the cable installation will slip to the 1990 good weather season. Then, the earliest anticipated in-service date for interim power would be late 1990. However, installation in late 1990 is earlier than any of the alternatives considered.

5.1.2 WATER AND GAS

MWRA will provide a new 24 in. ductile iron (or equivalent) (refer to Figure 5.1.1-1) diameter water main and a new 12 in. diameter steel gas main to Deer Island, along Route N-1A. The gas main is sized for a 26 MW on-site power plant. If a larger on-site power plant is ultimately recommended, the pipeline size would increase. For example, for a 58 MW power plant, the largest unit considered by the MWRA, Boston Gas Company has indicated a preliminary line size of 18 inches in diameter.

MASSACHUSETTS WATER RESOURCES AUTHORITY	FIGURE 5.1.1-1 RECOMMENDED PLAN UTILITY ROUTES



NOTE:

1. MARINE CONSTRUCTION SCHEDULED TO AVOID WINTER.
2. SUBSTATIONS INCLUDE EXISTING K-STREET, EXISTING CHELSEA AND FUTURE INTERIM DEER ISLAND. EARLY DESIGN OF CHELSEA SUBSTATION PROVIDES FOR IMPLEMENTATION OF INTERIM POWER CONTINGENCY PLAN, IF NECESSARY.
3. CONSTRUCTION ADJACENT TO BEACHES SHALL NOT BE PERFORMED BETWEEN MEMORIAL DAY AND LABOR DAY.
4. SCHEDULE FOR INTERIM POWER REPRESENTS EARLIEST POSSIBLE IMPLEMENTATION.
5. BASED ON PROGRESS AS OF JANUARY 1989, THE NEED TO IMPLEMENT THE INTERIM POWER CONTINGENCY PLAN SHOULD BE MADE.

MASSACHUSETTS WATER RESOURCES AUTHORITY

FIGURE 5.1.1–2
RECOMMENDED PLAN
OFFSITE UTILITIES SCHEDULE
CHELSEA PERM. POWER ROUTE N1A

MWRA_22
8–11–88

The gas main will originate at Boston Gas Company's existing supply on Railroad Street in Revere. It will be buried in a trench along with an 18 inch by 18 inch concrete ductbank and manhole system, along Route N-1A to the Winthrop/Revere town line, where MWRA Water Meter 41 is located. From Meter 41 to Deer Island, water, gas, and the ductbank will be installed along Route N-1A.

All utilities will be buried. If utilities can be installed in a common trench, each will be done separately to allow for safe maintenance. This will be determined during final design.

The ductbank system will include a reinforced concrete ductbank with four 5 inch diameter empty PVC ducts. Concrete electrical manholes will be located every 1,000-1,500 ft. The ductbank system will be installed with the water and gas in 1990 and 1991. Cable will be pulled through the ductbank in 1993 as part of the permanent power supply from BECo's Chelsea Substation. By installing a portion of the ductbank early, at the same time as water and gas, road excavation for installation of the Deer Island offsite utilities will only be required once.

As shown on Figure 5.1.1-2, water and gas should be available at Deer Island on May, 1991.

5.1.3 PERMANENT POWER FROM CHELSEA

The second permanent source of 115 kV electrical power will be BECo's Chelsea Substation (BECo Station No. 488). This substation must be modified to accommodate the new circuit which will consist of three separate cables. This new circuit will be sized to handle the peak electrical load at Deer Island. It provides 100 percent redundancy to the treatment plant. Each cable may be an oil-filled cable similar to the submarine cable installed from K-Street, except that the armoring is not required.

The cables will be installed in a concrete ductbank and manhole system. An 18 in. by 18 in. reinforced concrete ductbank with four 5 in. diameter PVC ducts will be constructed in 1993 along Route N-1, beginning at the Chelsea Substation. It will connect to the empty ductbank system installed with the water and gas in 1990 and 1991. Electrical manholes will be located every 1,000-1,500 ft, or as required.

Power cable will be pulled through three of the ducts. The fourth duct will be available for communication and control cable. The power cable, which will be spliced at every manhole, will be terminated at the new SF-6 Deer Island Substation.

As shown on Figure 5.1.1-2, permanent power from Chelsea will be available at Deer Island in 1994. At this time, the interim power source from K-Street will be disconnected and the permanent power from K-Street tied in. To meet this schedule, MWRA should sign a permanent power service agreement by January, 1991.

5.1.4 INTERIM POWER CONTINGENCY PLAN

Timely implementation of interim electrical power is crucial to supporting construction. Therefore, a contingency plan has also been considered in the event that the K-Street service

falls behind schedule. As previously discussed implementation of interim power by March, 1990 is the earliest possible in-service date. A more realistic date is late 1990 or beyond.

It is recommended that the progress of the K-Street interim service be closely monitored through the end of 1988. By January, 1989, field surveys and design should be completed, the cable should be in fabrication, and the permitting process should be well underway. At this point, a reasonably accurate prediction of the in-service date can be made. If the K-Street service is behind schedule or is predicted to fall behind schedule, then the contingency plan should also be implemented.

The contingency plan is to concurrently move forward with the service from the Chelsea Substation. Under this plan the cables from K-Street and Chelsea would both be brought to Deer Island and the first available cable would be connected to the Deer Island interim substation. The other cable would remain disconnected until the permanent Deer Island substation is erected. As shown on Figure 5.1.1-2, the present in-service date of the gas, water, and concrete ductbank is March, 1991. Since several additional months would be required to complete cable pulling and testing, interim power from Chelsea would be available in mid 1991. Since power is required in early 1991, it would be necessary to expedite the installation of the gas, water, and concrete ductbank by several months. This could be done by working additional construction crews along the route and/or by working through the winter. If it is necessary to implement this contingency plan, detailed schedules will be developed in January, 1989.

5.2 COST

Estimated costs were developed for the offsite portion of water, gas, and electric utilities required for the construction and operation of the secondary treatment plant. Costs were developed for a relative comparison of alternatives. Due to the uncertainty concerning subsurface conditions along the recommended routes, these costs should be considered as order-of-magnitude estimates.

As presented in Table 5.2-1, the project costs represent a present day order-of-magnitude capital cost estimate. They include a 35 percent allowance for engineering and contingency costs. These costs exclude taxes. Under the Federal Tax Reform Act of 1986, payments to a utility reimbursing costs for facilities to be owned by the utility are no longer exempt from Federal Taxation.

5.3 ENVIRONMENTAL IMPACT ASSESSMENT

5.3.1 LAND RESOURCES - LAND USE

The proposed project consists of the construction of subterranean utility lines. Land disturbance will be temporary in nature, and construction areas will be restored to their preconstruction condition. There will be no permanent changes to the existing land use along any of the proposed utility routes.

TABLE 5.2-1

PROJECT COSTS FOR RECOMMENDED PLAN

Interim and Permanent Power from K-Street(1)		
Submarine Cable		$12,000,000
Modifications to K-Street and Deer Island Interim Substations		2,500,000
	Subtotal	$14,500,000
Water, Gas and Empty Ductbank(2)		
	Subtotal	$13,700,000
Permanent Power from Chelsea(3)		
Completion of ductbank and cable		$ 7,000,000
Modifications to Chelsea Substation		1,700,000
	Subtotal	$ 8,700,000
Offsite Utilities Total(4)		$36,900.000

NOTES:

(1) Entire cost must be invested for interim power. Costs do not include new Deer Island Substation for permanent power.

(2) Empty ductbank installed from Railroad Avenue in Revere (gas supply) to Deer Island.

(3) Ductbank installed from Chelsea Substation to Railroad Avenue in Revere and cable pulled from Chelsea Substation to Deer Island.

(4) Does not include cost for new gas insulated substation required at Deer Island for the two permanent sources of power. This is an on-island cost and is included in STFP, Volume III.

5.3.2 LAND RESOURCES - PARKS AND RECREATIONAL RESOURCES

The parks along the proposed utility routes are valuable resources within the urban setting in which they are found. Recommended utility routes will pass by several parks and recreation areas and may cause minor impacts during construction.

Route N-1A passes Merritt Park in Chelsea, Suffolk Downs Racetrack in Revere, and Winthrop Beach in Winthrop. The utility lines will not cross these properties but will be placed within the abutting streets. Impacts to the parks which will occur during construction activities will be temporary. These include the potential for decreased accessibility, noise, and possibly dust. Negative impacts will be minimized by proceeding past the parks expeditiously.

The most significant potential impact will be along Yirrell Beach in Winthrop. The route crosses the beach for approximately 3,100 ft and will take approximately one month to complete. Construction along Yirrell Beach and by Winthrop Beach will be timed for the off season so that the peak beach use period (Memorial Day to Labor Day) will not be impacted.

Route S-1 will not directly impact any parks or recreation areas although the route does pass near Fort Independence Park from the harbor side. Impacts associated with noise are described in Section 5.3.7.

Measures to mitigate impacts are described in detail in Section 5.5.

5.3.3 LAND RESOURCES - TERRESTRIAL ECOLOGY

As previously discussed, Route N-1A, upon leaving the Chelsea Substation, follows existing roadways, thus having little or no impact on local terrestrial ecological resources. Mill Creek will be crossed utilizing the existing bridge; thus, wetland or stream border vegetation which may be associated with this area will not be affected.

The route leaves existing roadways to follow an abandoned railroad bed, presently devoid of vegetation, before crossing under the seawall to proceed along the beach for a distance of about 6,225 ft (1.1 miles). This route necessitates disturbing 2.1 acres of beach habitat. It also requires the removal of the vegetation present at the southern end of the beach. However, no unique, rare, or biologically important species of plants will be removed. The beach will be restored to its original condition upon completion of construction activities; thus, no permanent loss of habitat will occur.

The overall impact on Yirrell Beach should not be significant. However, beach vegetation is important for erosion control and soil stabilization. Thus, care must be taken during construction to minimize the area disturbed, and to ensure that adequate erosion protection is provided and that the beach is properly restored upon completion of construction.

The southern power route, S-1, will have a minimal impact on local terrestrial ecological resources. As previously stated, no unique, rare, or biologically important species of plants or animals inhabit areas along the proposed route. The 115 kV power supply will traverse an

abandoned field after leaving the K-Street Substation. This field is currently devoid of vegetation except along the margins. No loss of valuable habitat will therefore occur.

The remainder of Route S-1 will be submarine. Thus, no additional impact to terrestrial communities will occur.

5.3.4 LAND RESOURCES - WETLANDS AND FLOODPLAINS

Portions of the proposed northern utilities Route N-1A are within the floodplain, as described in Section 3.2. Construction within the floodplain within existing roadways is not expected to have an adverse impact on local resources. The potential for erosion and sedimentation resulting from trenching operations is considered small due to the short time period for construction and the small area impacted within the roadway at any time.

As previously stated, Mill Creek will be crossed using the existing bridge. Thus, no impacts are anticipated on wetland habitats which may be associated with this water body.

A total of 2.1 acres of Yirrell Beach will be impacted by the proposed utility route. As discussed in Sections 5.3.3 and 5.3.8, Yirrell Beach is a broad, rather flat cobble beach. Construction of the 15 foot trench along the seawall will take place above the mean high water mark; thus, no work will take place in the intertidal zone. Some vegetation present in scattered clumps at the southern end of the beach will be disturbed; however, no rare, unique, or otherwise biologically important species will be lost. Removal of vegetation in this area has the potential for increasing natural erosion processes; however, since this area has been accreting material over the past few years, an increase in erosion is not expected. The beach will be restored to its original condition at the completion of construction activities.
Overall, the potential impact to floodplains and wetlands from construction of the northern utility route is considered to be minimal and of little consequence to existing resources.

Construction along Route S-1 will occur within the floodplain since the majority of this route is underwater. The intertidal area of the Reserved Channel will be disturbed as a result of construction. The steep bank and intertidal area down to mean water west of the Summer Street Bridge will be excavated by means of a backhoe. However, the areas within the floodplain are degraded as described in Section 3.8.3 and are of little ecological value. No loss of sensitive plant or animal species or permanent loss of floodplain habitat will occur.

A detailed assessment of the potential impacts associated with cable-embedding operations on marine resources is provided in Section 5.3.8.

5.3.5 LAND RESOURCES - HISTORIC AND ARCHAEOLOGICAL RESOURCES

The documentary research and evaluations which have been performed on the recommended off-island utility route plans, have identified the following historical resources which are proximate to the northern utility supply route in the Town of Revere:

- o Slade Spice Mill;

- o Mary C. Burke School;
- o Site of the Battle of Chelsea Creek;
- o St. Paul's Episcopal Church;
- o Trinity Congregational Church;
- o Fire Station on Winthrop Avenue.

The Slade Spice Mill is included in the National Register of Historic Places; other resources listed above may also be historically significant. No modifications to, or removal from these resources will be required to implement the off-island utility supplies. Impacts to these resources, if any, will be limited to temporary access limitation, noise, and dust which may be associated with the brief period of time during which the utility route construction passes in the roadway near these resources.

For the northern utility supply route, N-1A, the only other potential area for impact is to archaeological resources which may exist along the shoreline in Winthrop, south of the seawall to Deer Island. In this area, documentary research can not eliminate the potential that an archaeological resource exists; thus, a field survey may be required to determine whether any archaeological resource exists in this area which would be affected by the project.

There will be no impacts to any archaeological resources which may exist at Sales Creek as the stream runs in a culvert, and the utility lines will be placed in the roadway above the culvert. There will also be no impact to any archaeological resources which may exist at Mill Creek, since the supply lines will be suspended below the bridge and not buried underground.

The interim power line, which will also be used to supply permanent power, is recommended to follow Route S-1 from the K-Street Substation in South Boston. There are no historic resources between the K-Street Substation and the Reserved Channel. The extent of sensitive archaeological areas is limited to walls and wharves on the edge of the Reserved Channel, which will not be affected by the project.

5.3.6 TRAFFIC

Impacts associated with constructing the water main, gas main, and permanent power along Route N-1A and constructing the interim and permanent power along Route S-1 are described below. Route S-1 requires either a minimal amount or no roadway construction, depending on the results of detailed engineering studies which will determine the most cost effective route to connect the K-Street Substation with the submarine cable. Route N-1A requires a comparatively large amount of roadway construction; it avoids the heavily congested Crest Avenue in Winthrop.

Typical construction methodology is described in Section 2.5 of this report. Detailed construction plans will not be available until final design. The discussion of impacts to roadways and traffic patterns assumes that the utilities will be placed to the side of the roadway and will not be constructed down the centerline. Impacts will consist of traffic delays and inconveniences to roadway users as described below. These impacts will be temporary and no permanent changes to roadways or traffic patterns will result from this project. Appendix A provides a detailed discussion of the traffic analysis and impacts associated with

this project.

For Route N-1A, two roadways in Chelsea will be affected by electrical power supply construction - Broadway and Eastern Avenue. Both roadways are between 37 feet and 53 feet in width; at least three lanes of traffic can be maintained along each roadway during construction.

Two roadways will be affected in Revere - Winthrop Avenue and Revere Beach Parkway. Revere Beach Parkway is the main east-west arterial through Revere and supports three lanes of traffic in each direction. The north-south portion of Winthrop Avenue is part of the north access route to Winthrop. Only one direction of traffic will be affected by construction on Revere Beach Parkway and at least two lanes of traffic can be maintained around construction. Bi-directional traffic can be supported on all segments of Winthrop Avenue during construction.

The affected roadways in Winthrop are Revere Street, Locust Street and Winthrop Shore Drive. Affected roadway peak hour vehicle volumes average 550 per hour in Winthrop. Peak hour traffic on Revere Street north of Crest Avenue is 1,280 vehicles per hour. At least two lanes of traffic can be maintained for routing vehicles around utility construction for the majority of the affected roadways. Traffic on these roadways is relatively light; bi-directional traffic can be accommodated provided that flagworkers are stationed at each end of the construction zone to assist in safe, smooth traffic routing.

Traffic impacts during construction can be quantified in terms of the increase in travel time due to construction activities occurring within the roadway. As stated above, there will be three affected roadways in Winthrop along Route N-1A.

Locust Street is a secondary residential street that primarily serves the local Winthrop neighborhood. Both Revere Street and Winthrop Shore Drive are used as local arterial streets; a portion of Revere Street also serves as one of two portals into and out of Winthrop. Previous analysis has shown that two lanes of traffic can be supported during service line construction on Revere Street and Winthrop Shore Drive and that running speeds in Winthrop average 25 mph.

Constructing utility lines in roadways will cause normal traffic flow interferences; drivers will decelerate as they approach the construction area, will drive at a lower running speed than normal through the construction area, and will accelerate up to normal running once free of the construction area. The following criteria have been used to develop conservative delay estimations:

1. Each driver begins to decelerate at least 500 ft from the construction area.

2. Acceleration and deceleration is at a constant rate of 2.5 feet per second per second.

3. Vehicles do not travel slower than 10 mph through the 200 feet-long construction area.

4. Delay is solely caused by a decrease in running speed; any delays that could be caused by vehicle interaction interferences have been disregarded.

It is possible that vehicle queuing could occur because of traffic disruptions caused by the utility construction. This would especially be true for Revere Street north of Crest Avenue during the peak hour. The average running speed in the construction area vicinity would then become some speed lower than 25 mph. A 15 mph running speed decrease would result in a 150 percent travel time increase through the area affected by construction. Travel time through the construction area would increase by 120 percent for isolated vehicles moving through the construction area.

However, the above travel time increases must be kept in perspective. An example is used for illustration. A driver travels 10 miles from Point A to Point B at 25 mph. Total travel time is 24 minutes. Six months later the driver travels the same route from Point A to Point B at 25 mph for 9 miles and 10 mph for 1 mile. Travel time is now 27.6 minutes, an increase of only 15 percent or less than 4 minutes.

It is expected that the entire cartway width will be resurfaced with permanent paving. The length of permanent pavement constructed in any given day will be limited by street intersection spacing as all traffic must be rerouted to other roadways during resurfacing operations.

Marine Traffic

It is expected that submarine cable will be placed 10 to 25 feet deep in submarine soils and 5 ft deep in rock outcroppings. The submarine cable will be installed using jetting-embedment equipment which injects the cable into the soils; a 45 cm by 5 feet deep slot will be cut in any rock outcropping to receive the cables.

Impacts to marine traffic will be minimal and relate generally to constraints on shipping traffic within the main shipping channel. It has been determined that of all the ships traveling in and out of Boston Harbor, approximately 88 percent have drafts less than 18 ft and are not confined to travel within the main shipping channel. The remaining 12 percent of the ships using Boston Harbor translates into approximately 1,200 trips per year, or nine trips per day which are restricted to the main shipping channel.

It is expected that construction within the main shipping channel will take only 2 to 3 days should no rock be encountered; construction will increase by 12 days should rock be encountered. The small percentage of ships required to use the main shipping channel will be disrupted for, at most, two weeks. Coordination with harbor authorities will be required to maintain optimal harbor travel conditions during this construction period.

5.3.7 NOISE

Construction of the off-island utility supplies will temporarily affect sound levels adjacent to the overland route in Chelsea, Revere, and Winthrop. Noise projections for the utility

supply construction activities, including excavation, installation of gas and water piping and electrical ductbank, backfilling and repaving, are described in Section 4.2.7.

Construction noise from these activities will be at a maximum level when the construction operation is directly in front of a residence. During excavation and installation, the maximum construction sound level is estimated to be 84 dBA at 50 ft. The sound level will thereafter diminish by 10 dBA the second day, 15 dBA the third day, 20 dBA the fourth day, and so forth. After approximately seven working days following excavation immediately in front of any residence, the sound level from the operation will drop to within 10 dBA of the ambient level of 50 dBA. The sound level will increase to the maximum level in the same manner. Roadway repaving will result in a maximum projected sound level of 86 dBA for less than one day.

Construction of the submarine cable route (S-1) will have a minimal effect on sound levels in Point Shirley, Winthrop, which is the closest residential area to the cable route. The noise from the submarine cable laying operation will be offshore and will be more than 2,000 ft from residential areas. Beyond 1,000 ft, the sound level resulting from submarine cable construction will be less than 10 dBA above ambient; for most portions of the route, the sound level from the operation will be less than the daytime ambient at the shoreline.

The MWRA has committed to a program to comply with stringent noise mitigation and to develop a program to avoid adverse noise impacts during construction and operation. Construction along the off-island utility supply routes will generate noise in locations where most mitigating strategies operative on the Deer Island construction site will not apply. Noise mitigation measures which are proposed for construction of the utility routes include:

- Route N-1A, providing permanent electrical power from BECo's Chelsea Substation, and potable water and natural gas to Deer Island, avoids construction adjacent to schools. Route S-1, providing interim and permanent power from BECo's K-Street Substation in South Boston, avoids construction in commerical/residential areas in South Boston.

- Construction along the seawall in Winthrop will not be performed during the peak beach recreational activity period of the summer, Memorial Day through Labor Day.

- The equipment used will be quieted to the maximum extent practicable, and its operation will not exceed the required Boston noise code level of 86 dBA at 50 ft for construction activities. Construction activities will be limited to one shift during the daytime.

5.3.8 MARINE RESOURCES

<u>Route S-1</u>

Construction of the proposed 115 KV submarine power cable along Route S-1 will be accomplished by use of a cable-embedment device such as the Harmstorf hydro-jet. This jetting device cuts a narrow trench in the seafloor and embeds a cable with a minimal amount of adverse impact to

marine resources. Under normal conditions, no dredging or disposal of dredge material is required. Any open trench, not filled in by a sand bedding is allowed to "silt-in" and, thus, no backfilling is necessary. In the event that substantial rock outcrops are found to be present along the proposed submarine cable route, an underwater "rock saw" may be used to cut a trench through bedrock. Sand will then be placed into the 10 ft trench to provide a bed and cover projection for the cable and to facilitate operation of the cable-embedding shoe. The placement of sand into the rock trench is not expected to have any adverse impact on local biota.

Alternately, if the rock saw cannot be successfully employed along the proposed submarine cable route, as discussed in Section 2.5.2, or, if there is minimal rock outcrops which makes mobilization of the rock saw uneconomical, conventional underwater excavation techniques (e.g. blasting and removal of rock via clamshell apparatus) may be required for construction of portions of the cable trench. At this time, and in the absence of detailed geophysical data from along the proposed submarine cable route, it has been assumed that the rock saw will be used to trench through rock outcrops, and that for purposes of impact assessment, no underwater blasting or disposal of rock material will subsequently be required.

For the proposed southern power route, S-1, there are several options for routing the cable to the Reserved Channel from BECo's K-Street Substation. Selection of one of these options would be based on the results of a detailed engineering study. The first option is to route the cable directly to the Reserved Channel west of the Summer Street Bridge. This will require some trenching in the intertidal area above mean high water with a backhoe, since the jetting device requires 2 to 3 ft of water to operate. However, the Summer Street Bridge has not been opened in a number of years. In the event that the jetting device cannot be modified to pass through the bridge to operate on the west side, there is a second option to place the cable in a steel pipe and lay it on the bottom of the Channel. The pipe will pass under the bridge to connect with the jetting device on the east side. The cable will then be embedded all the way to Deer Island. A third option is to run the power cable from the substation down Elkins Street and across Summer Street to the New Boston Station parking lot and directly into the Reserved Channel. The Reserved Channel in this area is bulkheaded such that no disturbance of intertidal habitat would be necessary. In the event that this third option is selected, some additional bulkheading may be required to support the power cable. This may entail driving additional pilings.

For impact assessment purposes, it has been assumed that the power cable will be routed to the west side of the Summer Street Bridge as shown on Figure 2.4.4-1, and that the jetting apparatus will be deployed within this embayment.

Operation of the cable-embedment device will present several sources of potential impact to marine resources. Temporary impacts associated with cable-embedding include turbidity, resuspension of bottom sediments containing contaminants, and loss of benthic habitat. Each of these impacts is discussed herein.

Turbidity

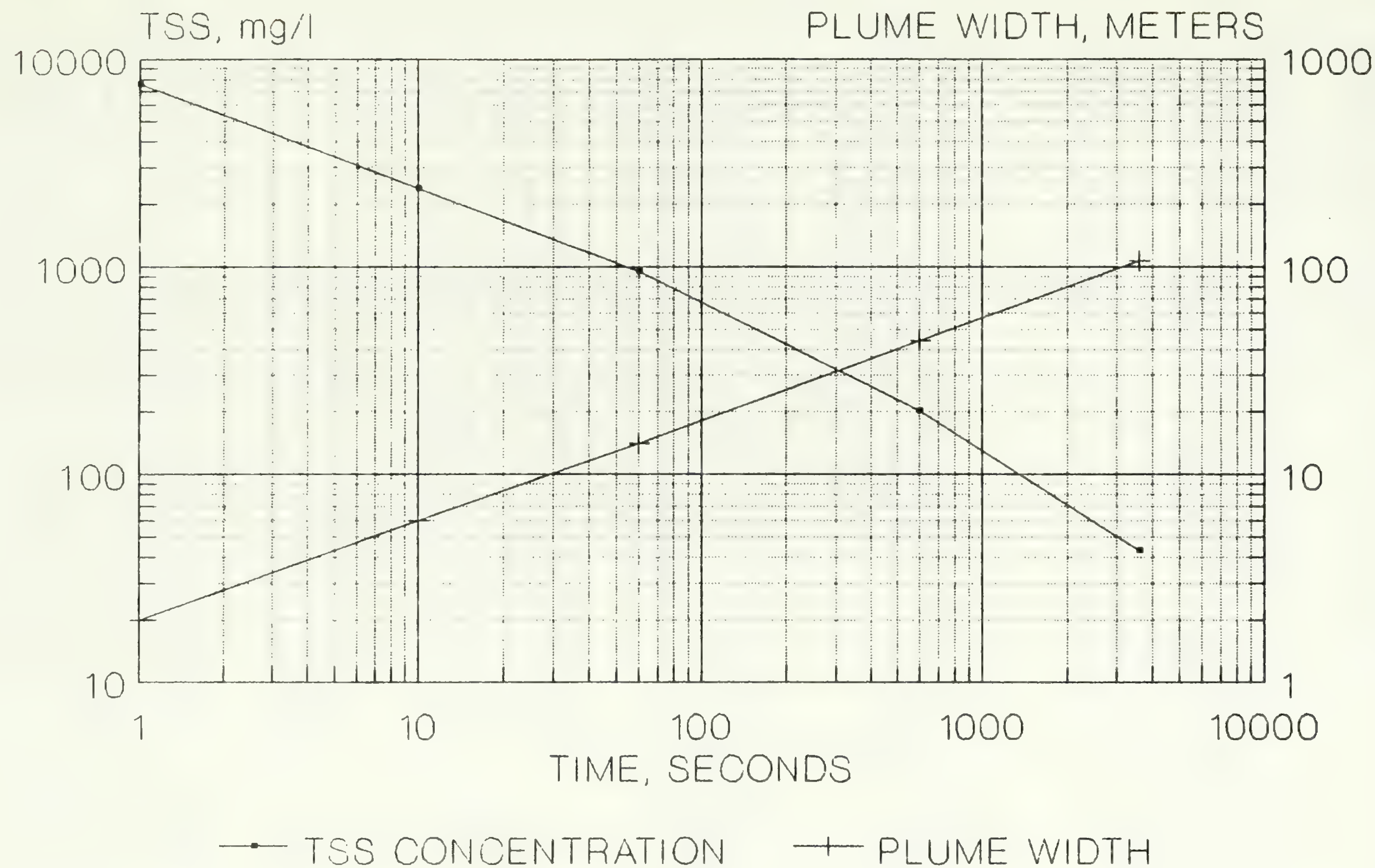
Turbidity results when sediment particles are resuspended in the water column. Turbidity can have a deleterious effect on phytoplankton by interfering with physiological processes. For example, turbidity can cut down the amount of sunlight able to penetrate the photic zone. This shading effect can reduce primary productivity, particularly during times of rapid turnover. The magnitude of this effect depends generally on current patterns and the sediment types being resuspended. Such shading will generally be short-lived because most suspended sediments will settle out within 24 hours.

Fish, because of their mobility, can avoid the short-term ill effects of turbidity (e.g., such as clogging of gill operculae) and are therefore less likely to be affected by activities associated with trenching. Less mobile benthic species, such as shellfish, are generally unaffected by turbidity unless turbidity is excessive or the condition continues for a prolonged period of time.

A comparison of turbidity resulting from cable-embedding operations with that of conventional cut and fill, dredging methods was made using the data from the Piers Project for Deer Island (MWRA 1987). For construction of the piers at Deer Island, an estimated 580 piles will be driven with a resultant 150,000 cubic yards dredged over a 3-4 month period. It was estimated, that under worst-case conditions, 3 cubic meters of sediment per day will be disturbed. Suspended solids concentrations alongside the dredge were estimated to be similar to those from the Thames River in New London, approximately 200-400 mg/l (MWRA 1987). The plume from dredging will be diluted to ambient conditions (10-20 mg/l) within 1 mile of the pier site and impacts to local marine biota were judged to be minimal, with the exception of bivalve species exposed to prolonged dredging (MWRA 1987).

Turbidity resulting from cable-embedding jetting operations is expected to be minimal. Turbidity effects are expected to increase if substantial ledge or rock outcrops are present. The jet embedment apparatus will cut a trench 0.75 meters wide by 3 to 4 meters deep with a minimum of turbidity. Suspended solids concentrations resulting from operation of the hydro-jet were modeled using the methodology outlined in Appendix E. Suspended solids concentrations in the water column are a function of particle size, dispersion, and diffusion. Using the approach outlined in Appendix E, a maximum suspended solids concentration was predicted to occur within 23 ft of the trench, within ten minutes of the jetting device's passage (Figure 5.3.8-1). Within 60 minutes of its passage, suspended solids concentrations are expected to return to ambient. Thus, when compared with typical cut and fill operations using conventional dredging techniques, turbidity is expected to be inconsequential, and should, therefore, have minimal adverse impact on local biota.

Effects of turbidity resulting from cable-embedding operations on spawning and nursery habitat for local finfish species will be minimal. The prime species of concern is the winter flounder which spawns throughout Boston Harbor from January through May. Flounder spawn on sandy bottoms in shoal waters and in backwaters of bays and estuaries. The eggs are demersal, adhering to the bottom. Flounder larvae exhibit mixed behavior, part benthic, part planktonic.



MASSACHUSETTS WATER RESOURCES AUTHORITY

FIGURE 5.3.8-1

PROJECTED DISPERSION OF SEDIMENTS FROM CABLE EMBEDDING

Cable embedding operations are not expected to have an appreciable effect on winter flounder spawning. The area affected by construction is small when compared to the available spawning habitat within the Harbor, and the turbidity associated with construction activities will be slight and generally localized.

Sediment deposition as a result of cable-embedding operations was estimated using the methodology outlined in Appendix E. It was estimated that maximum deposition will occur immediately adjacent to either side of the trench, with a maximum deposition of 0.4 mm. Sediment deposition diminishes with distance from the centerline of the trench so that, for example, the deposition at 50 m from the trench is less than 0.1 mm. Thus, no appreciable impact on local benthic populations, or demersal finfish eggs or larvae is anticipated as a result of cable-embedding.

Loss of Habitat

Along the entire length of the submarine cable route, approximately one acre of benthic habitat will be disturbed by cable embedding operations. Although the hydro-jet is the preferred method of trenching and presents the least potential for environmental impact, a conservative assumption is made that benthic organisms in the path of the hydro-jet will be destroyed or damaged as a result of embedding operations.

Trenching operations will disturb intertidal habitat in the Reserved Channel west of the Summer Street Bridge and on Deer Island. The intertidal area in the Reserved Channel is of marginal ecological value, as discussed in Section 3.8. Sediments near the Summer Street Bridge are azoic - essentially devoid of benthic organisms based on COE sampling conducted in 1987 (Hubbard 1987). Thus, disturbance of this habitat is of minimal consequence.

Information currently available suggests that the benthic communities in other areas of the Reserved Channel and west of Deer Island are typical of benthic communities elsewhere in Boston Harbor. As discussed in Section 3.8.3, the benthic infauna in the Reserved Channel is dominated by polychaetes, oligochaetes and amphipods. The other portion of the Reserved Channel (e.g., the turning basin and across in the main ship channel) has greater diversity and density of infauna.

Epifaunal assemblages in Boston Harbor are composed of hydroids, tunicates, bryozoans and the like; the macrobenthic community is typically composed of molluscs such as soft-shell clams, blue mussels, ribbed mussels, snails, and crustaceans such as lobster and crabs.

The loss of benthic organisms as a result of embedding operations is expected to be inconsequential. Impacts should not be felt at the species level. A few individuals may be lost but overall community structure should remain intact. Within the Reserved Channel, no changes in species composition are anticipated. Upon completion of trenching operations, and after a period of stabilization (i.e. when the trench fills in), habitat above the submarine cable will again be available for recolonization by benthic species. Recolonization from surrounding areas unaffected by construction activities is expected to occur. Short-term

changes in benthic species composition within areas outside the Reserved Channel are expected since opportunistic, pioneer species normally associated with stressed environments are generally first to recolonize an area after a disturbance. However, climax benthic assemblages along the proposed cable route should resemble existing communities over the long-term.

Resuspension of Bottom Sediments

Cable-embedding operations will result in some resuspension of bottom sediments. Chemical constituents within the resuspended sediment, including metals, PCBS, and PAHs, have the potential to affect the water column. Analysis of bulk sediment chemistry data of sediments along the proposed route indicates that concentrations of toxic materials in sediments are quite variable. A comparison of surface and core samples taken from Boston Harbor indicates that, with the exception of mercury, concentrations of metal and organic contaminants are generally higher in surficial sediments (Section 3.5.4).

As previously noted, resuspension of bottom sediments as a result of cable - embedding was modeled (Appendix E). Predicted suspended solids concentrations as the result of the jetting device's passage were determined to be minimal and of little consequence to local marine resources. Therefore, resuspension of contaminants contained in the sediments as a result of cable-embedding will also be minimal. Concentrations of contaminants in the water column will probably be less than that which occurs naturally from sudden ressuspension of sediments following coastal storms (e.g., nor'easters). In addition, the phenomenon will be localized and of short duration (2 to 3 weeks).

Winter flounder, because they are opportunistic and feed on a wide variety of benthic species, are frequently exposed to contaminants present in the surficial sediments. The resuspension of toxic materials contained in sediment in the water column, thus, provides an additional exposure pathway for such commercially sought species. However, the short-term nature of the exposure and the localized nature of this impact are not expected to have a deleterious effect on finfish within the vicinity of the proposed power route.

Overall, the effects of cable-embedding operations on local resources (e.g. finfish and soft-shell clam beds) should not be deleterious. The temporary and limited nature of the impacts associated with turbidity and sediment resuspension will most probably be of less consequence than episodes of storm-generated conditions within the Harbor. No permanent loss of benthic habitat will occur, and commercially valuable species such as lobster, soft-shell clams and winter flounder should not be adversely affected.

Route N-1A

From the standpoint of potential impacts to marine resources, Route N-1A will have essentially no effect on local marine biota, with the exception of that portion of the route which will utilize Yirrell Beach.

Yirrell Beach, as described in Section 3.8 is a broad, rather flat cobble beach which extends

from Winthrop Head to Deer Island on the seaward side. The beach has been an area of substantial accretion in recent years, such that large quantities of rock and cobble have been deposited along the seawall. No vegetation is present above the mean high water mark along the seawall.

At the point where the seawall ends, the beach widens into an upper beach and lower beach. As described in Section 3.8, the upper beach supports scattered clumps of vegetation, while the lower beach is intertidal and littered with flotsam and jetsam.

The proposed utility route follows the seawall along Yirrell Beach on the seaward side to Deer Island, necessitating disturbance of the beach for approximately 1.1 miles. Construction of a 15 ft-wide trench will therefore disturb approximately 2.1 acres of beach habitat. However, since all construction will take place above the mean high water mark, no impact on local marine resources in the intertidal area is anticipated.

5.3.9 MARINE ARCHAEOLOGY

As described in Section 3.9, an extensive literature search was conducted to determine the presence of marine archaeological sites within the pathway of the proposed underwater electric cable. There is no documentary evidence for the presence of historic shipwreck sites in the vicinity of Route S-1 crossing between Deer Island and the City of Boston at the southern or northern terminals of the cable. The extensive dredging and construction within the harbor from the late nineteenth century to the present further suggests that, if such wrecksites are found, their condition will be unlikely to warrant extensive scientific inquiry. However, prior to commencement of the cable embedding process, side scan sonar and a magnetometry survey will be conducted to verify the lack of any marine archaeological resources.

5.4 INSTITUTIONAL CONSIDERATIONS

The major institutional considerations for providing off-island electrical power, gas and water supplies to Deer Island include permitting, internal and external (to MWRA) coordination, and demand for unique construction resources.

Permitting and Coordinating Activities

Prior to construction of the interim power, water and gas utilities and permanent 115 kV power supplies to Deer Island, a number of federal, state and local permits and approvals will be required. Table 5.4.1-1 summarizes the types of permits/approvals which will be required, and the agencies responsible for them.

A preliminary implementation schedule for the project is shown in Figure 5.1.1-1. This schedule provides independent activities for the interim and permanent power supply from K-Street Substation along Route S-1, and for the permanent power, water and gas along Route N-1A from the north.

TABLE 5.4.1-1

UTILITY SUPPLY PERMITTING MATRIX

Permit (Approval Agency)	Activity Requiring Permit/Approval
Federal:	
Section 404 Permit (COE)	Submarine cable construction
Section 10 Permit (COE)	Installation of submarine cables in navigable water
Private Aid to Navigation (USCG)	Placement of temporary floats, moorings, etc, in areas affecting navigation
State:	
Water Quality Certification (DEQE-DWPC)	Federal or state permitting activities for actions involving discharges to water
Section 106 Historic Preservation Review (MHC)	Construction activities potentially affecting historic/archaeological resources
Ch. 91 Waterways License (DEQE)	Construction below mean high water or formerly submerged tidelands
Consistency Review (CZM)	Federal funding/permitting action for activity located within or affecting the coastal zone of Massachusetts
Energy Facilities Siting Council (EFSC)	Approval of plans for new gas and electrical transmission routes
Local:	
Wetlands Order of Conditions (Boston, Revere, Winthrop CON. COMs.)	Removing or altering land in or near water bodies within 100 feet of the 100-year flood plain
Road-Opening Permits (Winthrop, Revere, Chelsea, MDC, MA. DPW)	Construction in roadways

TABLE 5.4.1-1

UTILITY SUPPLY PERMITTING MATRIX (Continued)

Abbreviations

COE	-	U.S. Army Corps of Engineers
CON.COMS.	-	Conservations Commissions, Local Cities/Towns
CZM	-	Massachusetts Coastal Zone Management
DEQE	-	Massachusetts Department of Environmental Quality Engineering
DWPC	-	DEQE, Division of Water Pollution Control
EFSC	-	Massachusetts Energy Facilities Siting Council
MHC	-	Massachuestts Historical Commission
USCG	-	U.S. Coast Guard

A total of eleven months are shown for all permitting activities, which includes both preparation of permit applications and reviews/approvals by the appropriate agencies. For the submarine cable route, which is more critical in timing than the northern routes, all necessary permits/approvals are assumed to be obtained by June 1, 1989.

The maximum time period allowed for agency reviews in this schedule is six months; completion of engineering/design activities required for preparing the permits for the interim/permanent power supply from K-Street Substation is November, 1988. An additional one to three months will be available for agency reviews of certain applications such as the approval by the Energy Facilities Siting Council, the Section 10 and 404 permits (COE), and for partial submittals of the Chapter 91 Waterways License. Beyond the end of the permit schedule on June 1, 1989, an additional one to two months could be available for agency review. However, any additional time for permitting will result in a corresponding decrease in the available construction time required for the submarine cables; alternatively, submarine cable construction could be extended during November and December, 1989, to allow for an additional one to two months for permit reviews by agencies.

Permitting requirements for the northern utilities and for completing the permanent power from K-Street Substation (construction of a new switchyard on Deer Island) are less than those needed for the interim power supply, since these activities do not involve construction below the mean high water mark.

The permitting schedule represents a best case situation and provides a minimal degree of flexibility; the impact of appeals on certain of the requisite permit applications will extend the overall implementation of the project, beyond the schedule shown on Figure 5.1.1-1. Extensive internal and external (relative to MWRA) coordination will be required to support the scheduled activities. Coordination activities which will minimize the potential for permitting delays include:

- Agency Liaison - The need for close coordination between MWRA, BECo, and the permitting agency is of paramount importance in the timely processing of permit applications. In view of the large number and scope of permits needed for project implementation, it is recommended that a liaison from the State DWPC be assigned to the MWRA's Program Management Unit, as described in Section 6.6.2 of Volume VII of the STFP.

- Coordination of Engineering Activities with Regulatory Staff - Meetings between the Secondary Facilities Planning Project and State DWPC have indicated the desirability of close coordination between ongoing planning activities and regulatory review. For long-term permit applications such as the Chapter 91 Waterways License, involvement of the permitting agency throughout the course of the preliminary engineering activities is recommended to ensure final acceptance of the requested permit.

Route N-1A is the recommended route for permanent power, gas and water supply. Permits required to construct along this route will include a Wetlands Order of Conditions, a Section 106 Historic Preservation Review, a CZM Consistency Review, local road-opening permits from the towns of Winthrop, Chelsea, and Revere, and Massachusetts Energy Facilities Siting Council (EFSC) approval.

Route S-1 is the recommended route for interim and permanent power supply from BECo's K Street Substation. The following permits will be required: Wetlands Order of Conditions from Revere, Winthrop and Boston Conservation Commissions, DEQE Waterways Chapter 91, DEQE-DWPC Water Quality Certificate, COE Section 10 and 404 Permits, CZM Consistency Review, Private Aid to Navigation from U.S. Coast Guard, Massachusetts Energy Facilities Siting Council Review and Local Road-Opening Permits.

A summary of the various permits and lead times necessary to obtain them is provided below. Refer to Volume VII of the STFP for a detailed description of each of the permits.

COE Section 10 Permit

Section 10 of the Rivers and Harbors Act of 1899 prohibits the construction of any facility in or over the navigable waters of the United States without a permit from the U.S. Army Corps of Engineers. A permit therefore, is necessary for construction of structures beyond the mean high water mark in navigable and territorial waters. A Notice of Intent for a combined Waterways License, Wetlands Order of Conditions and this Section 10 Application should be made following consultation with the COE Division Office in Waltham. A CZM consistency determination is required for the Section 10 permit. Issuance of the Section 10 permit should occur within 6 months of filing the application. The jetting-embedment submarine cable installation technique is not considered by the COE to represent "dredge and fill" activities, which would otherwise require a 404 permit from the COE.

COE Section 404 Permit

Section 404 of the Clean Water Act requires permits for dredging and filling and the disposal of dredged materials in navigable waters of the U.S. The 404 Permit is the jurisdiction of the U.S. Army Corps of Engineers and is primarily concerned with the environmental impacts of dredge and fill activities.

Prior to issuance of a 404 Permit, a Water Quality Certificate must be obtained from DEQE and a Coastal Zone Management Consistency certification must be obtained from the CZM office of the Massachusetts Department of Environmental Management. Issuance of a 404 Permit should occur within 90-days of filing the application.

The jetting-embedment submarine cable installation technique may require a 404 Permit under two conditions:

1) If substantial rock outcrops are found to be present along the proposed submarine cable route, an underwater rock "saw" may be used to cut a trench through rock. Sand would then be placed in the 10-ft trench to provide a bed and protection for the cable. A 404 Permit may be required for placement of sand.

2) If there are minimal rock outcrops along the proposed submarine cable route making mobilization of the rock saw uneconomical, or if the rock saw cannot be used successfully to cut through the rock, conventional underwater excavation techniques may have to be used. Any blasting and removal/disposal of rock via clamshell apparatus will require a 404 Permit.

DEQE Waterways License-Chapter 91

A Waterways License under Chapter 91 must be obtained from the Waterways Division of DEQE for any construction, dredge and fill activities and the like undertaken within the tidelands (tidelands are all land and waters lying between the high water mark and the seaward limit of the Commonwealth's jurisdiction). A Waterways license in valid for five years.

The Waterways License regulation provides that if an Order of Conditions has been issued by a Conservation Commission under the Wetlands Protection Act, the DEQE is to presume that the project meets the Waterways License marine resource protection standards, unless the DEQE has information to the contrary. In addition, there is a limitation on this policy of differential review for areas where the project exceeds the jurisdiction of the local Conservation Commission. In this circumstance, the DEQE may perform its own review.

Eleven separate findings are necessary before a Waterways License can be issued. An application is made to the Division of Waterways of DEQE. DEQE must act on the application within a maximum of 90 days and a minimum of 30 days after the MEPA unit has determined that either: 1) an EIR is not required; or 2) a final EIR is available and there has been a corresponding notice published in the Environmental Monitor; or 3) a determination that the application is complete. A draft license can be issued after expiration of the 30 day comment period.

In his letter of May 18, 1988, the Secretary of the Executive Office of Environmental Affairs has provided certification on the Final Environmental Impact Report for the Secondary Treatment Facilities Planning Project, contingent on the need for evaluating the off-island utility supplies addressed in this supplement.

DEQE-DWPC Water Quality Certification

A Water Quality Certification (WQC) is issued by the Division of Water Pollution Control of DEQE. This WQC is always required in association with some other license or permit. For this project, the WQC is a pre-requisite for the Waterways License and the COE Section 10 Permit.

Private Aid to Navigation

This permit is required for the placement of temporary or permanent floats, moorings etc. in areas potentially affecting navigation. The time between notification and Coast Guard approval is usually 30 days.

Wetlands Order of Conditions

A Wetlands Order of Conditions from Boston and Winthrop Conservation Commissions will be required under the Wetlands Protection Act (310 CMR 10.00) for filling, removing or otherwise altering land in or near water bodies (within 100 ft of the 100 year floodplain). A Notice of Intent must be filed with the local conservation commissions and the Regional Office of DEQE (Note: DEQE and the U.S. Army Corps of Engineers have developed a joint Notice of Intent for the Wetlands Protection Act Order of Conditions, the Waterways License and COE permits). The Conservation Commissions will hold public hearings with 21 days after receipt of the NOI. Within 21 days of the close of the public meeting, the Conservation Commissions shall either: 1) determine that the area of which the proposed work is to be done is not significant to any of the interests identified in the Wetlands Protection Act; or 2) determine that the impacts are significant and issue an Order of Conditions, specifying the performance standards which the project must meet. Work that cannot be conditioned to meet required performance standards shall be prohibited in the Order of Conditions.

Section 106 Historic Preservation Review

Review of power, gas and water supply route alternatives will be conducted under Section 106 Historic Preservation. This review is necessary for removal or potential modification of structures which are eligible for inclusion on the National Register of Historic Places. Resources in the vicinity of the proposed work are identified in this supplement; no removal or potential modification of any resource is anticipated as a consequence of this utilities project. The on-going review process has a 9-month lead time.

CZM Consistency Review

The Massachusetts Coastal Zone Management Office, as part of the federal CZM program overseeing federal funding and permitting, will review activities located within or affecting the coastal zone of Massachusetts. The CZM Consistency Certification is required for the Corps of Engineers' Section 10 permit. The basis upon which the CZM Consistency Certification is made is the 13 CZM regulatory policies which are listed in 310CMR 20.99. MWRA and BECo, as appropriate as Applicants, must make the following certification to the CZM Office:

> "The proposed activity complies with the policies of the Massachusetts approved coastal management and will be conducted in a manner consistent with such policies."

CZM may require additional information, but generally the office will defer to the MEPA review

of the project, in which CZM participates. Procedurally, the CZM review includes a public notice, a 21 calendar day public comment period, and an optional public hearing. If CZM does not provide a consistency statement within six months, a presumption of concurrence is assumed.

Massachusetts Energy Facilities Siting Council

The Massachusetts Energy Facilities Siting Council is responsible for implementing energy policies to provide a necessary energy supply for the Commonwealth with a minimum impact on the environment. It is possible that an Occasional Supplement to an approved forecast can be filed with the Council for the approval of less than fifteen miles of transmission line and a capacity of 115 kilovolts or less and ancillary structures. The Council can, within six months from the date of filing a complete Occasional Supplement, render a decision approving it, approving it subject to stated conditions, approving it in part, rejecting it in part, or rejecting it.

Road-Opening Permits

Road opening permits will be required from the Towns of Winthrop, Revere, and Chelsea, the Metropolitan District Commission, and the State DPW. These permits basically grant the applicant permission to remove the roadway surface in order to perform construction activities. An application must be filed and must include detailed design drawings. Approvals will take from one to three months.

Demand for Unique or Scarce Construction Resources

Implementation of the northern utility supplies, i.e., permanent power from BECo's Chelsea substation, potable water and natural gas, will be performed using conventional construction materials and equipment. Consequently, no constraints which would be attributable to unique or scarce construction resources are anticipated.

Construction of the submarine cable route from BECo's K-Street substation will, however, require the use of specialized construction equipment involved with the jetting-embeddment (and rock saw equipment, if necessary) of the submarine cable. Several construction contractors have been identified which have the equipment and experience with this construction technology. The tight implementation schedule for this element of the utilities project will require early awarding by BECo of the construction contract to ensure the availability of this equipment for timely completion of the project.

5.5 MITIGATION MEASURES

A significant mitigation package was developed as an integral part of MWRA's decision to site the new secondary treatment facilities on Deer Island. Because MWRA is committed to alleviating the impacts of the treatment facilities, the previous mitigation commitments are also an integral part of the facilities planning process.

The mitigation commitments address a broad range of environmental, technical, and institutional issues for both construction and operation of the secondary treatment facilities. Summary descriptions of each of the mitigation commitments and a statement of the applicability of each commitment for use as an evaluation criterion were provided in the Technical Memorandum "Proposed Criteria for Detailed Evaluation of Alternatives, Secondary Treatment Facilities Plan, May 13, 1987". A comprehensive listing of all mitigation commitments for the new facilities is contained in Volume VII, Section 10.1.1 of the STFP, which incorporates commitments made in the February 24, 1988 Memorandum of Understanding (MOU) between MWRA and the Town of Winthrop. These commitments were reviewed to categorize all necessary mitigation commitments and associated environmental controls that support the plans for providing off-island utility supplies to Deer Island. A summary of these commitments and environmental controls specific to the utility supply plans, including additional, proposed mitigation measures, is provided below.

Utility Coordination

Implementation of the recommended off-island utility plan will facilitate the provision of several long-term benefits to the Town of Winthrop, as committed to in the MOU:

- New Water Main Construction - MWRA will prepare a preliminary engineering study of the new water main supply to Deer Island to assess the storage needs, points of connection to the Winthrop system, metering and any improvements needed in the Northern High Distribution System which is the source for the new water supply. The new storage and transmission/distribution line will jointly provide for the long-term needs of Deer Island and Winthrop, as mutually agreed to by the Town of Winthrop and MWRA.

- New Gas Main - The gas main described in this supplement to the STFP will be constructed to serve the new treatment facilities on Deer Island. To the maximum extent possible, the new gas main will be constructed in the same right-of-way as that selected for the new water main, and will be constructed at the same time as the water main. Appropriate connections will be made to the gas distribution system of the town, including any necessary metering. The MWRA will prepare a preliminary engineering study of the proposed new gas main to assess the size, points of connection to the town's system, and proposed metering.

- Interim Power Supply - The MOU assumed that interim power would be supplied to Deer Island via an overland route through Winthrop, and committed to consideration of the aesthetics of the interim power supply, and disruption to the town associated with construction of the interim power supply. The recommended plan for interim power supply in this supplement to the STFP will virtually eliminate disruption to the Town of Winthrop through the use of a submarine cable route from the south across Boston Harbor.

Noise Control

MWRA has committed to comply with all legal standards, and has set a noise abatement goal that goes beyond simply adhering to applicable codes. MWRA will examine the need for noise abatement throughout the planning, design, construction, and operation of the facility to avoid adverse noise impacts.

Overland construction of the utility supplies and their associated impacts to commercial and residential areas are unavoidable given the utility needs of the new Deer Island wastewater treatment facilities and the locations of the off-island sources for these utility supplies. The recommended utility routes which have been selected, and the recommended plans for their implementation, provide for significant noise mitigation to the extent possible given these constraining factors. In this regard, the recommended northern utility route avoids construction adjacent to schools in Winthrop; construction of the southern permanent electrical power supply route has only minimal noise impacts to commercial/residential areas. Furthermore, the use of the southern route for meeting interim electrical power needs eliminates multiple overland route construction activities which would otherwise affect Chelsea, Revere and Winthrop.

Recommended additional noise mitigation measures for construction of the northern utility supply route include the following:

- Construction along the seawall in Winthrop would not be performed during the peak beach recreational activity period of the summer, from Memorial Day through Labor Day.

- The construction equipment used would be quieted to the maximum extent practicable, and its operation will not exceed the applicable noise code. Construction activities would be limited to one shift during the daytime.

Traffic

The mitigating considerations noted above for noise control, also apply to the mitigation of traffic impacts associated with construction of the overland portions of the utility supplies. Utility route selection and construction plans provide for mitigating traffic impacts to the extent possible given the locational constraints of utility sources and land uses between these sources and Deer Island. The MOU committed to the following mitigation measure which directly applies to utility supply construction:

> For paved streets disturbed by construction of the new water main and the new gas main, MWRA will repave the streets curb-to-curb, including restoration of the road base as necessary. For rights-of-way on streets that are not paved, rights of way will be restored to preconstruction conditions, including full revegetation as appropriate.

Additional traffic mitigation measures which are proposed for the recommended utility supply construction are as follows:

- o In Chelsea and Revere, roadways which are effected by utility route construction would be restored to pre-construction conditions.

- o Implementation of good construction practices, such as provision of flag workers, temporary barriers, and posting will be used to ensure safe roadway use adjacent to construction areas.

Further Measures to be Examined

Additional mitigative measures that have been proposed in this supplement to the STFP include the following:

Historic and Archaeological Resources (subject to approval by the Massachusetts Historical Commission):

- o The evaluations described in this document have concluded that the potential for structural impacts to historic resources is minimal. This conclusion should be verified as part of the detailed engineering effort for the project.

- o The evaluations herein have concluded that the potential for impacts to archaeological resources in the overland utility route south of the seawall in Winthrop to Deer Island is minimal. In this area, a Phase II archaeological survey may be required to verify the lack of any archaeological resource which would be affected by the project.

- o The marine archaeological evaluations herein have similarly concluded that the potential for impacts to underwater archaeological resources from submarine cable installation is minimal. It is recommended that the results of side scan sonar and magnetometry surveys, which will be performed to support the design of the submarine cable route, be evaluated to confirm the lack of these underwater resources.

Construction in Floodplains:

- o No permanent fill should be placed above the original contours of the area; where the utility route is in beaches, preconstruction surface conditions would be ensured following construction activities.

- o In floodplains and also in roadways, dust resulting from construction activities would be controlled by wetting.

- o Siltation control from any dewatering operations, if needed, will be specified in the construction plans and specifications.

SECONDARY TREATMENT FACILITIES PLAN
SUPPLEMENT TO APPENDIX H, VOLUME III

APPENDIX A

TRAFFIC

MASSACHUSETTS WATER RESOURCES AUTHORITY
Deer Island Service Line Construction
Transportation Impacts

July 1988

PEER Consultants, PC
Philadelphia, PA

MASSACHUSETTS WATER RESOURCES AUTHORITY
Deer Island Service Line Construction
Transportation Impacts

TABLE OF CONTENTS

MASSACHUSETTS WATER RESOURCES AUTHORITY
Deer Island Service Line Construction
Transportation Impacts

Potential local traffic impacts associated with the construction of electric power, natural gas and potable water supply service lines through sections of metropolitan Boston to Deer Island are discussed in the pages that follow.

INTRODUCTION

The service lines to be constructed will directly support the new 500 million gallon per day wastewater treatment plant that will be built on Deer Island to provide both primary and secondary treatment of wastewater for the metropolitan area. The new plant will replace existing primary treatment facilities located on Deer and Nut Islands. The following service lines require construction:

1) Potable Water Supply.
2) Interim Electric Power Supply.
3) Permanent Electric Power Supply.
4) Natural Gas Supply.

A new 24-in potable water supply line will be constructed underground from Meter 41 to Deer Island. Meter 41 is located at the Revere and Winthrop boundary near the intersection of Route 145 and Upland Street.

A new 24-kv interim electric power line will be constructed underground from the Massachusetts Electric Company (MECo) Revere 7 substation or from the Boston Electric Company (BECo) K Street substation to Deer Island. The MECo substation is located in Revere near the intersection of Route 16 and Railroad Street approximately 300-ft west of the Route 16 and Route 1A junction. The BECo substation is located in South Boston in the vicinity of K Street and First Street.

A new 24-kv permanent electric power line will be constructed to Deer Island from the BECo Chelsea substation or the above described BECo K Street substation. The Chelsea substation is located in Chelsea in the vicinity of Eastern Avenue and Crescent Avenue.

A new 16-in natural gas supply line will be constructed from the Boston Gas Supply source located adjacent to the MECo Revere 7 substation in Revere.

The proposed service line routes require both land and submarine construction. It is expected that service lines will be constructed concurrently whenever their routes coincide. The sections that follow describe service line routes and construction procedures; present roadway volume cartway width field measurements, curbside parking practice observations and Boston Harbor marine traffic data; and provide service line construction traffic impact assessments. The discussion begins, however, with a presentation of findings.

FINDINGS

At least one lane can be maintained for routing vehicles around service line construction for the majority of affected roadways. For the more heavily traveled roadways, at least two and usually three lanes of traffic can be maintained. Bi-directional traffic could be accomodated on one-lane roadways provided that flag-workers are stationed at each end of the construction zone to assist in safe, smooth traffic routing.

Tafts Avenue between Shirley Street and the beginning of the Deer Island causeway sea wall is too narrow for even one traffic lane to be kept free should electric power, natural gas and potable water supply service lines be constructed coincidently on Tafts Avenue. However, at least one lane of traffic could be maintained along Tafts Avenue provided no more than two service lines are constructed; these two lines must be constructed in a common

trench as close to the curb line as feasible. Construction could not occupy more than 11-ft of street. The third service could be constructed either prior to or after the two service line construction work. Construction would continue for at least eight working days. It is also not possible to route traffic onto adjacent roadways to circumvent construction because all intersecting roads dead-end at the beach or the bay.

Tafts Avenue is approximately 1,865-ft long; about 800-ft of service line can be located out of the roadway in the unimproved land between Deer Island and Adams Street provided that land use arrangements with the Commonwealth of Massachusetts are possible. Alternately, the service lines could be constructed in the roadway, and traffic could be routed using a temporary roadway constructed on the adjacent land. Impacts to traffic will be in only one direction for the 265-ft section between Shirley and Elliot Streets. The roadway is one-way northbound along this section. Tafts Avenue is also the only access road between Deer Island and the mainland.

Service line location in roadways has a direct impact on the ability to maintain traffic routes around construction. It may be necessary to detour traffic to adjacent streets should service lines require placement near the cartway centerline and would ensure that traffic would be precluded from Tafts Avenue in Winthrop. It will be necessary to detour traffic off service line roadway sections during permanent paving operations.

All truck traffic to Deer Island must be routed through Winthrop during service line construction. One proposed service line route is located in truck route roadways. Deer Island truck traffic could be slowed and possibly prevented along the segments described above should the route be selected that encompasses truck route segments. Coordination between the town of Winthrop, the service line contractor and contractors working on Deer Island would help minimize disruption to service line and Deer Island construction and mitigate traffic hazards for Winthrop by assuring that effective traffic routing procedures are developed and implemented.

In areas where there is heavy curbside parking use, daily construction shifts could be extended, and work could be scheduled so that parking disruptions are minimized.

Using Route S-1 for the interim and permanent power supply route and Route N-1 or Route N-1a for the gas, potable water, and interim power supply would minimize traffic impacts. Route S-1 requires no roadway construction and Route N-1 requires the least amount of roadway construction. Construction along the Deer Island truck route in Winthrop would also be avoided.

Submarine cable construction will require work to be performed in President's Road, one of the two main navigation channels in Boston Harbor. President's Road is approximately 1,200-ft wide and has an average sounding depth of 40-ft.

Approximately 600-ft of submarine cable will be laid each construction day. At least one-half the route will require passage through rock requiring an initial trench to be cut into the rock. Rock trench construction will advance at 100-ft per day. All construction activities will be staged from a barge that will be anchored at all times at the construction site. The construction area will occupy at most 600-ft of President's Road.

At least 88 percent of Harbor traffic consists of vessel with drafts of 18-ft or less. Vessels with larger drafts have averaged 1200 total trips per year into the Harbor from 1972 to 1985. There is no significant difference in large draft vessel monthly trip totals from month to month. At most, 9 Harbor arrivals could be expected on any given day into the Harbor. It is unlikely that maximum harbor departures would coincide with maximum harbor arrivals.

It is expected that submarine cable will be constructed out of President's Road wherever possible and along one side when not possible. However, it will be necessary to bisect the channel at least at one point. Disruptions to Boston Harbor traffic will be minimal. Most Harbor traffic is not constrained to travel only the navigation channel because of large drafts;

construction will also occupy only 600-ft of channel. At most, large draft vessels that can only move in the Harbor using the channel would be precluded for at most 8 days. Judicious construction scheduling for a period where large draft vessel traffic is expected to be minimal would mitigate impacts.

ROUTE DESCRIPTIONS

Figures 1 through 8 show the proposed construction routes. There are eight alternative routes:

1) Route N-1: Gas, Water, Power.
2) Route N-1a: Gas, Water, Power.
3) Route N-1b: Gas, Water, Power.
4) Route N-1c: Gas, Water, Power.
5) Route N-1d: Gas, Water, Power.
6) Route N-2: Power.
7) Route S-1: Power.
8) Route S-2: Power.

Routes N-1 through N-1d require only land construction; Routes N-2 and S-2 require both land and marine construction; and Route S-1 requires marine construction and a negligible amount of land construction. Each route is described further below.

Route N-1 will initially begin at the MECo Revere 7 substation west of Route 1A. Boston Gas Supply is also located here. The power and gas supply service line route travels east on Route 16 (Revere Beach Parkway) and then southeast and south on Winthrop Avenue to the MWRA Meter 41 potable water connection located in the vicinity of Winthop Avenue on the Winthrop/Revere Town Line, where the potable water supply line joins the power and gas service lines route. Route N-1 can then take five possible routes through Winthrop.

Figure 1
Alternate Route N-1

Figure 2
Alternate Route N-1A

Figure 3
Alternate Route N-1B

Figure 4
Alternate Route N-1C

Figure 5
Alternate Route N-1D

Figure 6
Alternate Route N-2

Figure 7
Alternate Route S-1

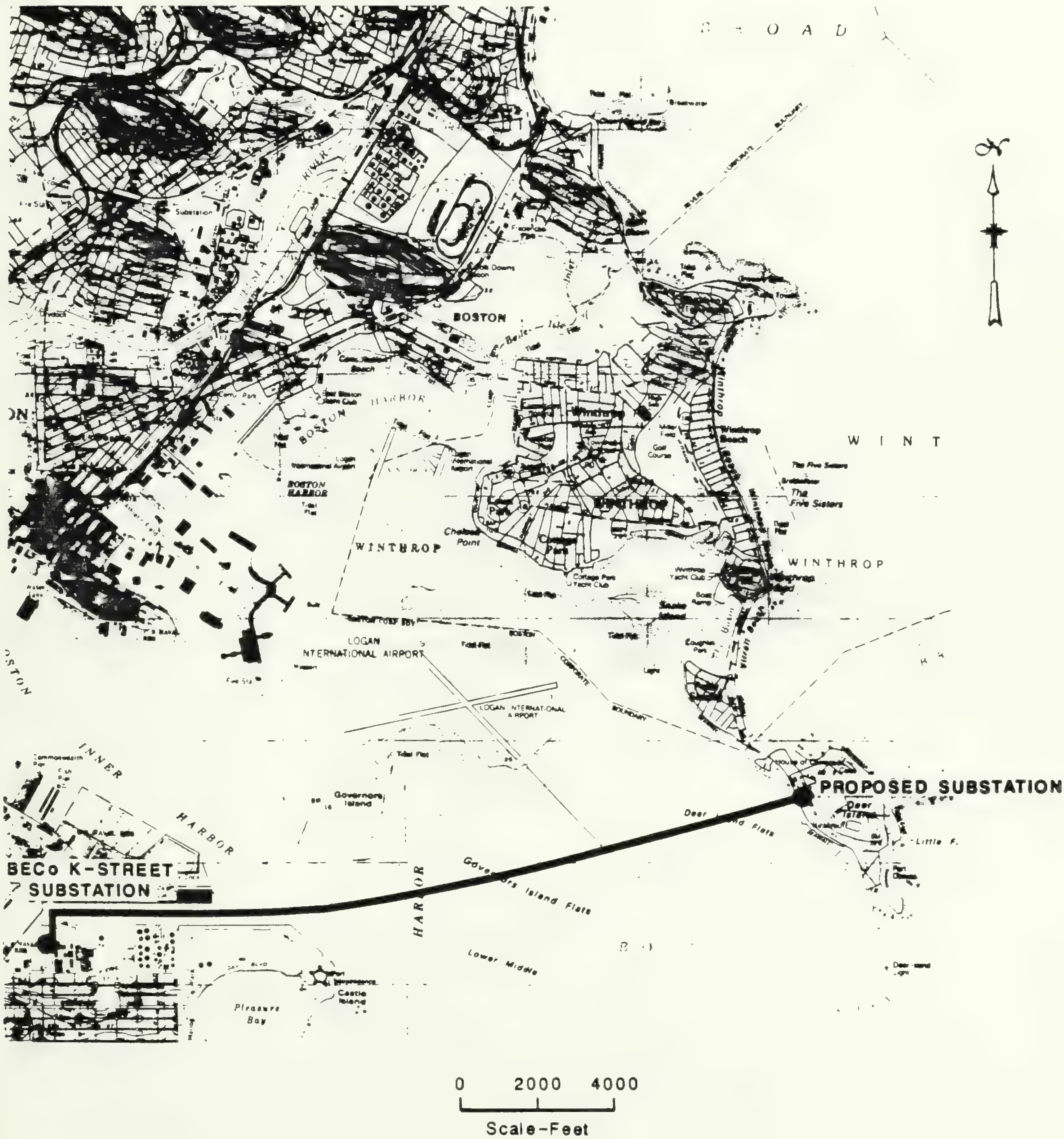
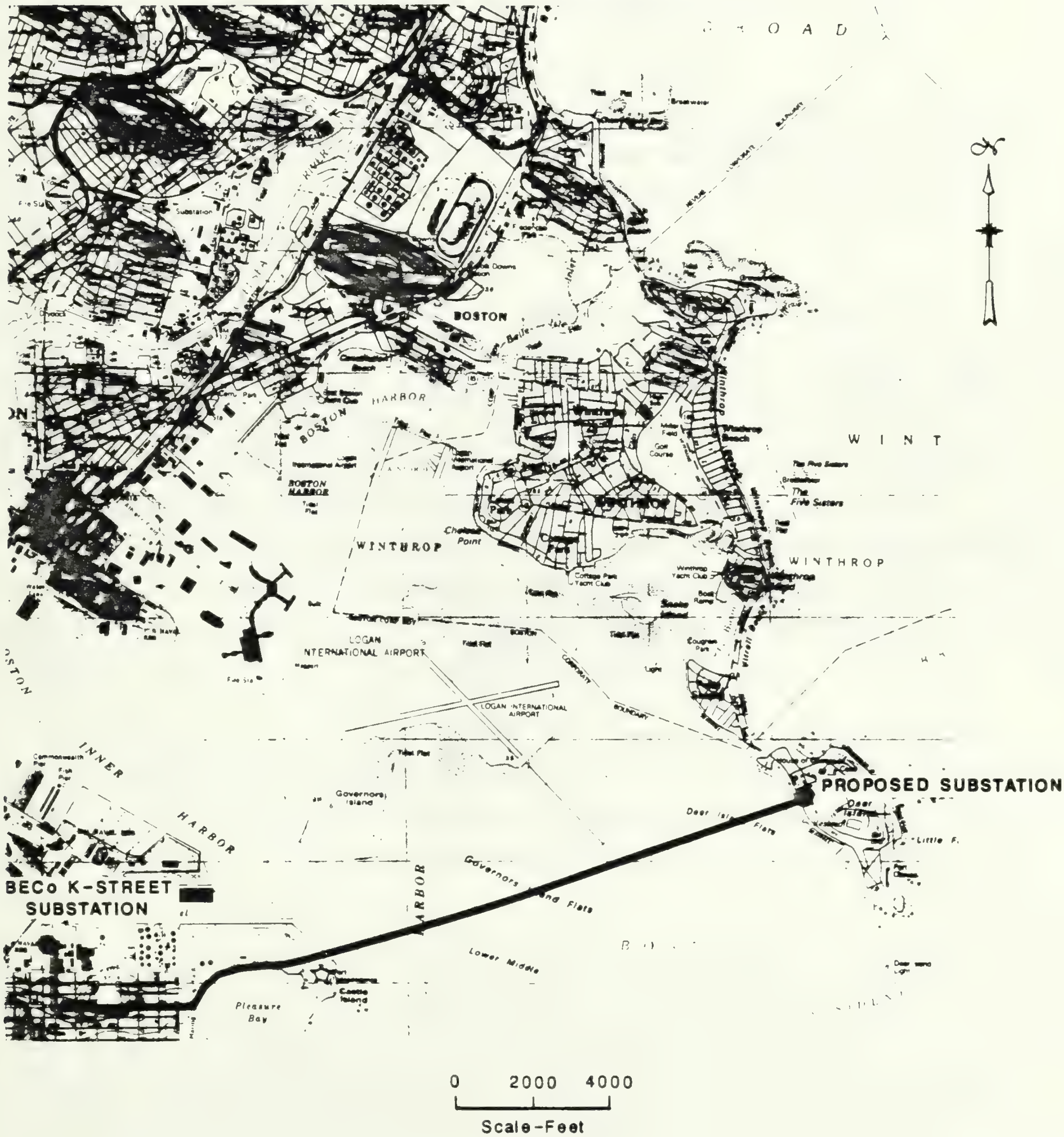


Figure 8
Alternate Route S-2



Route N-1 continues south on Winthrop Avenue, Revere Avenue, Crest Avenue and Winthrop Shore Drive. The route then leaves the road and parallels the sea wall on its landward side around Cottage Hill and Yirrell Beach, and then travels south on Brewster Avenue and cross-country to Deer Island. Brewster Avenue is an unpaved right-of-way between the seawall and the first row of houses.

Route N-1a allows the heavily patronized commercial district on Crest Avenue to be avoided by routing the service lines southwest on Revere Street from south on Revere Street, and then southeast on Locust Street to connect with Winthrop Shore Drive.

Route N-1b is identical to Route N-1 until it reaches Crest Avenue. The route then travels southwest on Revere Street, southeast on Shirley Street, south on Veterans Road, east on Washington Avenue and south on Shirley Street and Tafts Avenue to Deer Island. A large percentage of Route N-1b is also part of the Deer Island truck route. Route N-1c allows beach construction to be avoided by requiring the route to turn west on Tewksbury Street from Winthrop Shore Drive to connect with Shirley Street. The route then continues south on Shirley Street and Tafts Avenue to Deer Island. Finally, Route N-1d will turn west on Adams Street from Yirrell Beach should the unimproved land between Adams Street and Deer Island be unavailable for use.

Route N-1 will be extended to the BECo Chelsea substation should this route be selected for supplying permanent power to the new plant. The power supply service line route travels north on Eastern Avenue and Broadway, and east on Route 16 to Railroad Street where it connects with the above described Route N-1.

Route N-2 also originates at the BECo Chelsea substation in Chelsea. The permanent power supply service line route travels south on Eastern Avenue, west on Marginal Avenue and south under the Chelsea River through an existing conduit. The route then travels cross-country to southeast on Shelby Street, northeast on Saratoga Street, southeast on Neptune Street, northeast on

Bennington Street and southeast on Trident Street. The route then travels across Orient Heights Beach where it leaves land and travels southeast past Logan Airport and Chelsea Point to Deer Island.

The electric power supply service line Route S-1 and Route S-2 both originate at the BECo K Street substation in South Boston. Route S-1 travels north cross-country a short distance to the Reserve Ship Channel. The line then travels northeast across Boston Harbor to Deer Island. Route S-2 travels south on K Street, east on Broadway and north and east on William J. Day Boulevard to Fort Independence. The line then leaves land and travels northeast across Boston Harbor to Deer Island.

Table 1 presents the approximate route distances.

Table 1
Approximate Route Distances

	Roadways (ft)	Cross-Country (ft)	Marine (ft)	Total (ft)
Route N-1 base*	19,800	5,700	-	25,500
Route N-1a	20,800	5,700	-	26,500
Route N-1b	25,600	1,200	-	26,800
Route N-1c	25,100	1,200	-	26,300
Route N-1d	22,925	2,575	-	25,500
Route N-1 ext.	7,100	1,000	-	8,100
Route N-2	10,700	3,000	18,800	32,500
Route S-1	-	600	20,400	21,000
Route S-2	8,700	800	13,100	22,600

*Route N-1 base begins at MECo Revere 7 substation.

DATA ASSEMBLY

The following data listed below were assembled for use in analyzing potential traffic impacts. Assembly procedures are described below.

1) Roadway Volumes.
2) Cartway Widths.
3) Curbside Parking.
4) Marine Traffic.

Roadway Volumes

Roadway volume data were collected to develop an estimate of the amount of traffic that would be disrupted along a given roadway by service line construction. State and local governments and planning agencies were contacted to obtain existing information. A summary of the collected roadway volume data used in the analysis is presented in Table 2.

Figure 9 shows the collected roadway volume data listed in Table 2 physical relation to the proposed service line routes.

Additional data were collected at three locations to supplement the above listed existing information:

1) Intersection of Eastern Avenue and Broadway.

2) Intersection of Eastern Avenue, Marginal Street, Central Avenue and Chelsea Street.

3) Intersection of Winthrop Avenue, Revere Street and Winthrop Avenue.

The additional data collection has been limited to morning and afternoon peak hour turning movement counts. Its purpose was to provide an approximation of the peak volume of vehicles that could be expected along the roadways of interest. Winthrop intersection turning movement count data used

in analyzing traffic impacts that could result from constructing the new Deer Island Wastewater Treatment Plant were also used in the present investigation.

Table 2
Existing Roadway Volume Data Summary

Roadway	Location	Description
Route 16	Chelsea	East of N.E. Expressway - Hourly volumes
	Revere	East of N. Shore Drive - " "
Winthrop Avenue	Revere	West of Bennington - " "
Winthrop Av/ Winthrop Prkwy	Revere	Intersection Peak Hour Turning Movements
Bennington Street	E. Boston	South of Winthrop - Hourly volumes
Bennington/Neptune	E. Boston	Intersection turning movements - 1/2 hour volumes
Chelsea/Saratoga/ Neptune	E. Boston	Intersection turning movements - 1/2 hour volumes
Revere/Crest/ Highland	Winthrop	Intersection Peak Hour Turning Movements
Shirley/Veterans	Winthrop	" " " " "
Veterans/Washington	Winthrop	" " " " "
Washington/Shirley	Winthrop	" " " " "
Tafts/Otis/Elliot	Winthrop	Intersection Hourly Volumes
Winthrop Shore Drive	Winthrop	Saturday hourly volumes
Wm. J. Day Blvd	S. Boston	Between 1st and K Sts - Hourly volumes
Broadway/K	S. Boston	Intersection turning movements - 1/2 hour volumes
Broadway/Eastern	Chelsea	Intersection Peak Hour Turning Movements
Broadway/Marginal	Chelsea	Intersection Peak Hour Turning Movements

Cartway Width Measurements

Field measurements for roadways affected by service line construction were obtained the weeks of 19 October 1987 and 23 April 1988. These measurements are listed in Table 3. The measured widths range from 21-ft for roadways traveling through Shirley Point in Winthrop to 74-ft for a section of Neptune Street located between Saratoga Street and Bennington Street. The average cartway width is 36-ft.

Curbside Parking Practice

Curbside parking field observations are listed in Table 4. Two observations along each street section were obtained. Field observations of Winthrop curbside parking practice obtained during the week of 19 October 1987 and 23 April 1988 showed heavy use of available space for about 50 percent of the total route lengths.

Marine Traffic

Submarine construction could disrupt marine traffic traveling in and out of Boston Harbor. The following marine traffic data were collected for use in analyzing marine traffic impacts.

1) Daily movements of container ships over 1600 tons from April 1987 to March 1988. (Source: Coast Guard)

2) Daily movements of vessels using Massachusetts Port Authority facilities in 1987. (Source: Massachusetts Port Authority)

3) Current daily schedules for local cruise and commuter ferry vessels.

Table 3

Cartway Width Measurements

STREET	CROSS STREET ONE	CROSS STREET TWO	AREA TYPE	ROADWAY LENGTH (ft)	CARTWAY WIDTH (ft)	SERVICE TYPE	ROUTE	LOCATION
REVERE	Upland	Highland	R	1584.0	35.5	W,G,E	N-1 to N-1d	WINTHROP
	Highland	Summit	R/C	739.2	34.1			
	Summit	Shirley	R/C	528.0	30.8			
CREST	Grovers	Highland	C	1056.0	25.8	W,G,E	N-1,N-c	
LOCUST	Revere	Wnthrp Shr	R				N-1a	
SHIRLEY	Revere	Cross	R/C	792.0	25.8		N-1b	
	Cross	Veterans	R	739.3	26.3			
VETERANS	Washington	Hadassah	R/C	5544.0	33.3		N-1b	
WSHNGTN	Elmwood	Shirley	R/C	1056.0	25.0		N-1b	
SHIRLEY	Washington	Tewksbury	C	528.0	34.0		N-1b	
	Tewksbury	Terrace 1	R/C	792.0	25.7			
	Terrace 1	Terrace 2	R/C	1056.0	41.0			
	Terrace 2	Yrrll Bch	R	52.8	29.9			
	Yrrll Bch	Petrel	R	792.0	32.8		N-1b	
	Petrel	Bayview	R	1056	25.8			
	Bayview	Tafts	R	52.8	26.0			
TEWKSBURY	Wnthrp Shr	Shirley	R				N-1c	
TAFTS	Shirley	Elliot	R	264	21.1		N-1b, N-1c	
	Elliot	Sea Wall	R	792	21.3			
	Sea Wall	Deer Islnd	R	792	21.1			
WNTHRP SHR	Beacon	Veterans	R	5280.0	35.8	W,G,E	N-1b,N-1c,N-1d	
	Veterans	Grovers	R	1056.0	34.9			
WNTHRP PKWY	Upland	Winthrop Ave	R		36.0	G,E	N-1	REVERE
WNTHRP AVE	Wnthrp Pkwy	Summer	R	792.0	31.4	G,E	N-1	
	Summer	Crescent	C/R	1320.0	31.1			
	Crescent	Bennington	R	950.4	31.4			
	Bennington	ReverеBchPkwy	C	792.0	33.2			
REVERE BCH	Wnthrp Ave	Rt 16	C	792.0	35.8	G,E	N-1	
	"	"	R	4224.0	36.3			
REVERE BCH	Rt 16	Brdwy Off Rmp	C	4488.0	35.9	E	N-1	
	Brdwy Off Rmp	Broadway	R	1056.0	36.2			
BROADWAY	Brdwy Off Rmp	Rt 16 E OnRmp		1056.0	48.3	E	N-1	CHELSEA
	Rt 16 On Rmp	Eastern Ave	C	1584.0	42.3			
EASTERN AVE	Broadway	Louis	C/R	1320.0	41.8	E	N-1	
	Louis	Gulf Sign	C/R	1320.0	51.7		N-1,N-2	
	Gulf Sign	Central	I	2112.0	52.7		N-2	
MARGINAL	Central	Willow	I	3696.0	37.8	E	N-2	
SHELBY	Lexington	Saratoga	C/R	475.2	34.3	E	N-2	E. BOSTON
SARATOGA	Shelby	Neptune	C/R	528.0	48.0	E	N-2	
NEPTUNE	Saratoga	Bennington	C	158.4	74.3	E	N-2	
	Bennington	Frankfurt	R	369.6	24.0			
BENNINGTON	Neptune	Trident	C/R	6072.0	57.0	E	N-2	
K STREET	E 1st	Broadway	R	792.0	34.0	E	S-2	S. BOSTON
E.BROADWAY	K	L	C	686.4	60.7	E	S-2	
	L	Farragut	R	3432.0	49.8			
	Farragut	Wm J Day		105.6	49.8			

Table 4

Curbside Parking Practice

					OBSERVATION 1				OBSERVATION 2	
STREET	CROSS STREET ONE	CROSS STREET TWO	AREA TYPE	LOCATION	SIDE A PARKING YES/NO	% PRKNG	SIDE B PARKING YES/NO	% PRKNG	SIDE A % PRKNG	SIDE B % PRKNG
REVERE	Upland	Highland	R	Winthrop	Yes	15%	Yes	0%	25%	50%
	Highland	Summit	R/C		No sign	0%	No sign	0%	0%	0%
	Summit	Shirley	R/C		Yes	10%	Yes	60%	5%	20%
CREST	Grover	Highland	C		N		Y	80%		95%
LOCUST	Revere	Wnthrp Shr	R		Yes	50%	Yes	50%	40%	40%
SHIRLEY	Revere	Cross	R/C		No sign	0%	Yes	50%		40%
	Cross	Veterans	R		No		No			
VETERANS	Washington	Hadassah	R/C		Yes	75%	No		50%	
WSHNGTN	Elmwood	Shirley	R/C		No		No			
SHIRLEY	Washington	Tewksbury	C		Yes	75%	Yes	90%	75%	95%
	Tewksbury	Terrace 1	R/C		No		Yes	90%		95%
	Terrace 1	Terrace 2	R/C		No		Yes	0%		50%
	Terrace 2	Yrrll Bch	R		No		No			
	Yrrll Bch	Petrel	R		Yes	10%	No		10%	
	Petrel	Bayview	R		Yes	50%	No		45%	
	Bayview	Tafts	R		No		Yes	50%		50%
TEWKSBURY	Wnthrp Shr	Shirley	R		No		Yes	90%		95%
TAFTS	Shirley	Elliot	R		No		Yes	80%		25%
	Elliot	Sea Wall	R		No		Yes	20%		0%
	Sea Wall	Deer Islnd	R		No		No			
WNTRP SHR	Beacon	Veterans	R		N		Y	30%		15%
	Veterans	Grovers	R		N		Y	10%		15%
WNTHRP PKWY	Upland	Winthrop Ave	R	Revere	N		N			
WNTHRP AVE	Wnthrp Pkwy	Summer	R		Y	0%	Y	0%		
	Summer	Crescent	C/R		Y	2%	Y	2%		
	Crescent	Bennington	C/R		Y	95%	Y	95%	95%	95%
	Bennington	RevereBchPkwy	C		N		N			
REVERE BCH	Wnthrp Ave	Rt 16	C		N		N			
	"	"	R		N		N			
REVERE BCH	Rt 16	Brdwy Off Rmp	C		N		N			
	Brdwy Off Rmp	Broadway	R		N		N			
BROADWAY	Brdwy Off Rmp	Rt 16 E OnRmp		Chelsea	N		N			
	Rt 16 On Rmp	Eastern Ave	C		Y	40%	Y	40%	98%	98%
EASTERN AVE	Broadway	Louis	C/R		Y	85%	Y	85%	95%	95%
	Louis	Gulf Sign	C/R		N		N			
	Gulf Sign	Central	I		N		N			
MARGINAL	Central	Willow	I		ROADWAY UNDER CONSTRUCTION					
SHELBY	Lexington	Saratoga	C/R	E. Boston	Y	95%	Y	95%	100%	100%
SARATOGA	Shelby	Neptune	C/R		Y	100%	Y	100%	100%	100%
NEPTUNE	Saratoga	Bennington	C		Y	95%	Y	95%	100%	100%
	Bennington	Frankfurt	R		N		Y	50%		0%
BENNINGTON	Neptune	Trident	C/R		Y	80%	Y	80%	80%	80%
K STREET	E 1st	Broadway	R	S. Boston	Y	85%	Y	85%	100%	100%
E.BROADWAY	K	L	C		Y	95%	Y	95%	90%	90%
	L	Farragut	R		Y	90%	Y	90%	90%	90%
	Farragut	Wm J Day			Y	90%	Y	90%	90%	90%
WM J DAY	Broadway	Ft Indpndce	Ocean		N		Y	30%		90%

4) 1986 and 1987 yearly volumes for the following vessel types using Massachusetts Port Authority (Massport) Port of Boston facilities:

   a) Tankers
   b) Full Container Vessels
   c) Container Feeder Barges
   d) General Cargo Vessels
   e) Dry Bulk
   f) Passenger Vessels
   g) Other

5) Boston Harbor vessel movement information contained in the "Draft Supplemental Environmental Impact Statement - Boston Harbor Wastewater Conveyance System," USEPA, Volume II, 1 April 1988.

CONSTRUCTION PROCEDURES

The subsections below describe roadway and submarine construction procedures for the service lines.

Roadway Construction

Service lines in roadways are normally constructed in the following manner:

1) A service line trench is excavated to the desired depth.

2) Gravel bedding is placed along the trench bottom to provide firm and uniform support for the service line.

3) Service line sections are placed in the trench and jointed together.

4) The trench is backfilled with suitable material, and the material is compacted to the desired density.

5) A temporary asphalt patch is placed over the trench.

6) Permanent pavement is installed after a suitable time interval to allow for any settlement that may occur.

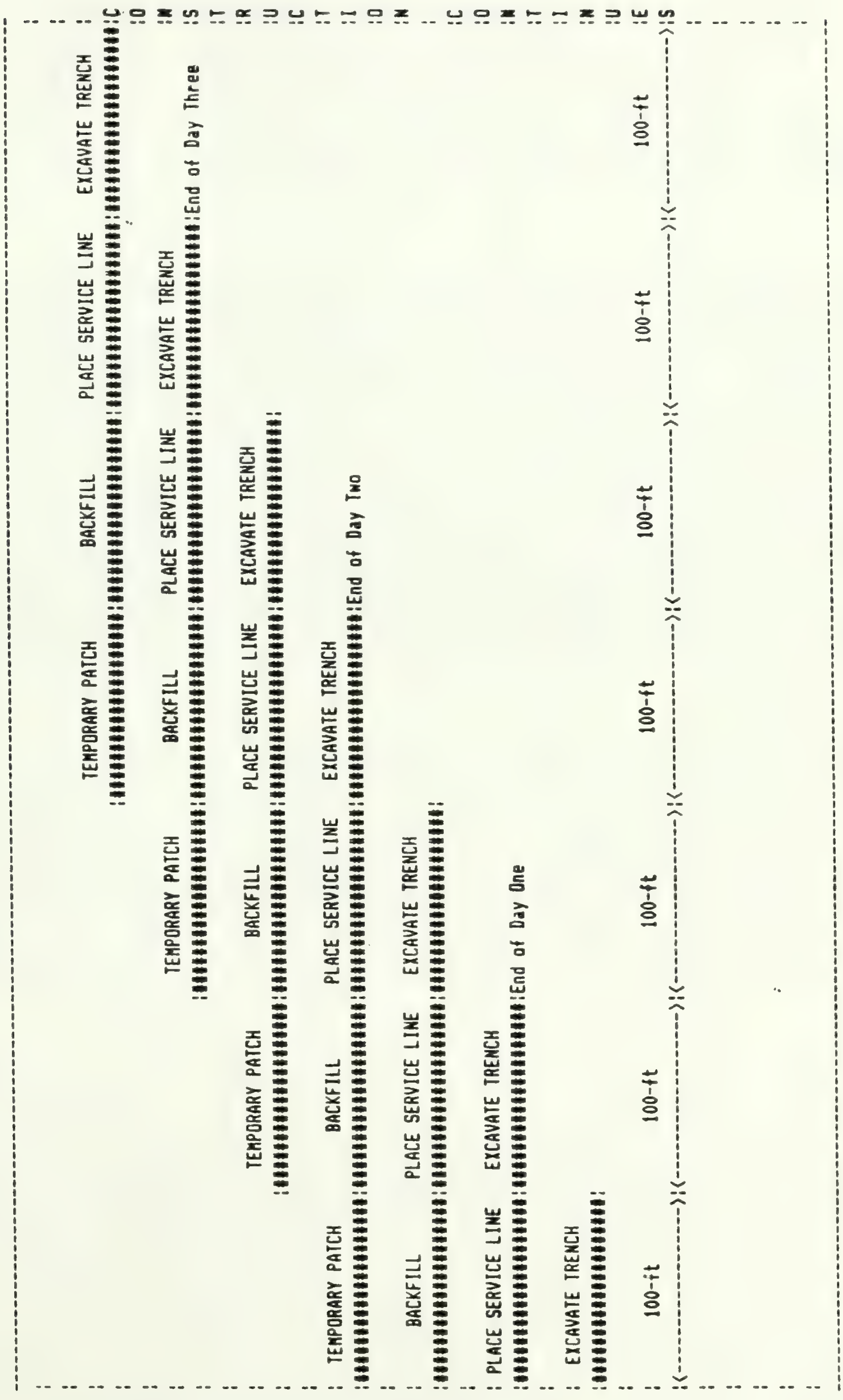
Implicit in the construction sequence are requirements for trench wall bracing, utility relocations, dewatering operations, and pipe valve installations, harnessing, blocking and testing. It is expected that the length of open excavation will be limited to 200 feet to facilitate traffic routing around the construction. Excavation, service line placement, backfilling and temporary trench patching will be conducted concurrently and coordinated so that total distance occupied by construction is minimized.

Figure 10 shows a typical construction sequence. Total construction will occupy a roadway length of 400-ft without accounting for 100-ft transition distances at each end for re-establishment of normal traffic patterns. At a minimum, 600-ft of roadway will be occupied by construction.

It is expected that the entire cartway width will be resurfaced with permanent paving. Permanent pavement resurfacing is generally performed in late summer or early fall when weather conditions are most favorable. The length of permanent pavement constructed in any given day will be limited by street intersection spacing as all traffic must be rerouted to other roadways during resurfacing operations.

Figure 10

Typical Service Roadway Construction Sequence



Construction will occupy at least 6-ft of cartway width for electric power line construction, 10-ft for electric power and natural gas supply or water supply and natural gas supply construction, and 14-ft where all three service lines reside in the same roadway. In the two latter cases, the service lines will be constructed using a common trench. Cars require a one-way minimum lane-width of 8-ft for passage around construction; trucks and buses need a one-way minimum lane-width of 10-ft with 12-ft a more preferable alternative.

The service line location in the cartway will have a direct impact on the traffic environment during construction. Its location is a major factor in assessing how traffic could be routed around the construction. Water supply lines are typically offset from the roadway centerline above and to the side of sewer lines. Utility and gas lines are also offset from the roadway centerline, and are above and to the side of the water supply line away from the sewer line. Alternately, the required service lines could be placed on opposite roadway sides. It is feasible that service lines residing in the same roadways could be constructed separately at different times. However, this scenario is undesirable as it requires disrupting roadway traffic more than once.

Another consideration during Deer Island service line construction is that a portion of the construction is in roadways that are part of the Winthrop truck route. Service line construction is scheduled for completion prior to 1991 and before Deer Island pier facilities are in operation. All Deer Island truck traffic will be routed through Winthrop using the truck route, possibly slowing truck traffic during service line construction.

Marine Construction

It is expected that cable will be placed 10-ft deep in submarine soils. Cables will be installed using conventional furrow practices, where the ocean

floor is cut open, the cable laid and cover replaced on top of it. Alternately, the cable can be left exposed allowing sediments to fill in the opening as a result of normal sedimentation and wave activity. It is expected that all cables will be laid in a single pass. Approximately 50 percent of the submarine route will require construction through rock.

Construction will be staged from a specially equipped barge whose dimensions will not exceed 60-ft by 180-ft. A 200-ft construction corridor is also required along all sides of the barge. The barge will remain anchored at the construction location during construction. It is estimated that approximately 600-ft of cable can be laid on average per day. Additional construction is required to cut a cable route through rock. Rock-cutting will advance at a rate of 100 feet per day.

TRAFFIC IMPACT ASSESSMENT

The paragraphs below describe traffic impacts that could result from roadway and submarine service line construction.

Roadway Construction

It is expected that service lines will be located in roadways offset from the centerline and that a roadway curb or shoulder will constitute a construction limit boundary. Service lines that occupy the same roadway will be constructed using a common trench. Construction will occupy a total of 6-ft, 10-ft or 14-ft of the cartway width depending on how many service lines are residing in the same roadway. Table 5 shows the minimum cartway widths required to allow for one and two lane passage around construction.

Table 5

Minimum Cartway Widths - Traffic Routing

	Elec Power Supply Line (ft)	Elec Pwr or WtrSpply&Gas Supply Line (ft)	Elec Power, Gas & Water Supply Line (ft)
One Lane: Cars only*	14	18	22
One Lane: All vehicles**	16	20	24
Two Lane: Cars only*	22	26	30
Two Lane: All vehicles**	26	30	34

* Lane width is 8-ft
** Lane width is 10-ft

Table 6 shows the number of lanes that can be maintained along each roadway section for routing vehicles around service line construction At least one lane for traffic routing can be left open along the majority of roadways. The exception is Tafts Avenue and Tewksbury Street in Winthrop where no lanes are available for vehicle passage. Tafts Avenue is along a portion of Routes N-1b, N-1c and N-1d just prior to Deer Island, and is the only access route between Deer Island and the mainland. It is also part of the truck route. Tewksbury is a quiet, residential street approximately 550-ft in length that connects Shirley Street with Winthrop Shore Drive.

Tafts Avenue is one-way north between Shirley Street and Elliot Street. Only southbound traffic will be precluded from this roadway section. Traffic in both directions will be prevented from using Tafts Avenue between Elliot Street and the beginning of the Deer Island causeway sea wall located in the Adams Street vicinity.

The land adjacent to Tafts Avenue south of Yirrell Beach between the sea wall end and Deer Island is unimproved. This section is part of Route N-1 and

Table 6

Lane Number Around Roadway Construction

STREET	CROSS STREET ONE	CROSS STREET TWO	AREA TYPE	ROADWAY LENGTH	CARTWAY WIDTH	SERVICE TYPE	ROUTE	LOCATION	ONE LANE CARTWAY WIDTH DIFFERENCE* CARS E	ALL E	CARS EB/WB	ALL EB/WB	CARS E,G,W	ALL E,G,W	TWO LANES CARTWAY WIDTH DIFFERENCE* CARS E	ALL E	CARS EB/WB	ALL EB/WB	CARS E,G,W	ALL E,G,W	LANE NUMBER CARS ONLY	ALL VHCLS
				(ft)	(ft)						(ft)						(ft)					
REVERE	Upland	Highland	R	1584.0	35.5	E,G,W	All N-1	Winthrop					13.5	11.5					5.5	1.5	TWO	TWO
	Highland	Summit	R/C	739.2	34.1		N-1b						12.1	10.1					4.1	0.1	TWO	TWO
	Summit	Shirley	R/C	528.0	30.8		N-1b						8.8	6.8					0.8	-3.2	TWO	ONE
CREST	Grovers	Highland	C	1056.0	25.8	W,G,E	N-1,N-1c						3.8	1.8					-4.2	-8.2	ONE	ONE
LOCUST	Revere	Wnthrp Shr	R	550.0	26.0	E,G,W	N-1a						4.0	2.0					-4.0	-8.0	ONE	ONE
SHIRLEY	Revere	Cross	R/C	792.0	25.8	E,G,W	N-1b						3.8	1.8					-4.2	-8.2	ONE	ONE
	Cross	Veterans	R	739.3	26.3								4.3	2.3					-3.7	-7.7	ONE	ONE
VETERANS	Washington	Hadassah	R/C	5544.0	33.3	E,G,W	N-1b						11.3	9.3					3.3	-0.7	TWO	ONE
WASHNGTN	Veterans	Shirley	R/C	1056.0	35.0	E,G,W	N-1b						13.0	11.0					5.0	1.0	TWO	TWO
SHIRLEY	Washington	Tewksbury	C	528.0	34.0	E,G,W	N-1b						12.0	10.0					4.0	0.0	TWO	TWO
	Tewksbury	Terrace	R/C	792.0	25.7								3.7	1.7					-4.3	-8.3	ONE	ONE
	Terrace	Shirley	R/C	1056.0	41.0								19.0	17.0					11.0	7.0	TWO	TWO
	Shirley	Yrell Bch	R	52.8	29.9								7.9	5.9					-0.1	-4.1	ONE	ONE
	Yrell Bch	Petrel	R	792.0	32.8	E,G,W	N-1b						10.8	8.8					2.8	-1.2	TWO	ONE
	Petrel	Bayview	R	1056	25.8								3.8	1.8					-4.2	-8.2	ONE	ONE
	Bayview	Tafts	R	52.8	26.0								4.0	2.0					-4.0	-8.0	ONE	ONE
TEWKSBURY	Shirley	WnthrpShr	R	550.0	19.0		N-1c						-3.0	-5.0					-11.0	-15.0	ZERO	ZERO
TAFTS	Shirley	Elliot	R	264	21.1	E,G,W	N-1b, N-1c				3.1	1.1	-0.9	-2.9			-4.9	-8.9	-8.9	-12.9	ZERO	ZERO
	Elliot	Sea Wall	R	792	21.3						3.3	1.3	-0.7	-2.7			-4.7	-8.7	-8.7	-12.7	ZERO	ZERO
	Sea Wall	Deer Islnd	R	792	21.1		N-1b,N-1c,N-1d				3.1	1.1	-0.9	-2.9			-4.9	-8.9	-8.9	-12.9	ZERO	ZERO
WNTHRP SHR	Beacon	Veterans	R	5280.0	35.8	W,G,E	N-1, N-1a						13.8	11.8					5.8	1.8	TWO	TWO
	Veterans	Grovers	R	1056.0	34.9								12.9	10.9					4.9	0.9	TWO	TWO
WNTHRP PKW	Upland	Winthrop Av	R		36.0	G,E	N-1	Revere			18.0	16.0					10.0	6.0			THREE	TWO
WNTHRP AVE	Wnthrp Pkwy	Summer	R	792.0	31.4	G,E	N-1				13.4	11.4					5.4	1.4			TWO	TWO
	Summer	Crescent	C/R	1320.0	31.1						13.1	11.1					5.1	1.1			TWO	TWO
	Crescent	Bennington	R	950.4	31.4						13.4	11.4					5.4	1.4			TWO	TWO
	Bennington	RevereBchPk	C	792.0	33.2						15.2	13.2					7.2	3.2			TWO	TWO
REVERE BCH	Wnthrp Ave	Rt 1a	C	792.0	35.8	G,E	N-1				17.8	15.8					9.8	5.8			TWO	TWO
	"	"	R	4224.0	36.3						18.3	16.3					10.3	6.3			THREE	TWO
REVERE BCH	Rt 16	Brdwy Off R	C	4488.0	35.9	E	N-1		21.9	19.9					13.9	9.9					THREE	TWO
	Brdwy Off R	Broadway	R	1056.0	36.2				22.2	20.2					14.2	10.2					THREE	THREE
BROADWAY	Brdwy Off R	Rt 16 E OnRap		1056.0	46.3	E	N-1	Chelsea	34.3	32.3					26.3	22.3					FIVE	FOUR
	Rt 16 On Ra	Eastern Ave	C	1584.0	42.3				28.3	26.3					20.3	16.3					FOUR	THREE
EASTERN AV	Broadway	Louis	C/R	1320.0	41.8	E	N-1		27.8	25.8					19.8	15.8					FOUR	THREE
	Louis	Gulf Sign	C/R	1320.0	51.7		N-1,N-2		37.7	35.7					29.7	25.7					FIVE	FOUR
	Gulf Sign	Central	I	2112.0	52.7		N-2		38.7	36.7					30.7	26.7					FIVE	FOUR
MARGINAL	Central	Willow	I	3696.0	37.8	E	N-2		23.8	21.8					15.8	11.8					THREE	THREE
SHELBY	Lexington	Saratoga	C/R	475.2	34.3	E	N-2	East Boston	20.3	18.3					12.3	8.3					THREE	TWO
SARATOGA	Shelby	Neptune	C/R	528.0	48.0	E	N-2		34.0	32.0					26.0	22.0					FIVE	FOUR
NEPTUNE	Saratoga	Bennington	C	158.4	74.3	E	N-2		60.3	58.3					52.3	48.3					EIGHT	SIX
BENNINGTON	Neptune	Trident	C/R	6072.0	57.0	E	N-2		43.0	41.0					35.0	31.0					SIX	FIVE
K STREET	E 1st	Broadway	R	792.0	34.0	E	S-2	South Boston	20.0	18.0					12.0	8.0					THREE	TWO
E.BROADWAY	K	L	C	686.4	60.7	E	S-2		46.7	44.7					38.7	34.7					SIX	FIVE
	L	Farragut	R	3432.0	49.8				35.8	33.8					27.8	23.8					FIVE	FOUR
	Farragut	Wm J Day		105.6	49.8				35.8	33.8					27.8	23.8					FIVE	FOUR
WM J DAY	Broadway	Ft IndpndceOcean		3432.0	45.2	E	S-2		31.2	29.2					23.2	19.2					FOUR	THREE
					36.5																	

* Cartway width difference = total cartway width minus width occupied by construction.

Route N-1a. The land is owned by the Commonwealth of Massachusetts. At this location, service lines could be constructed alongside the roadway rather than in the roadway so that Deer Island truck access is not disrupted, provided that arrangements for its use could be reached with the Commonwealth. Alternately, service lines could be constructed in the roadway; traffic would then be routed using a temporary roadway constructed on the adjoining land.

Closing Tafts Avenue would result in seriously disrupting traffic to Deer Island for at least 8 construction days if all three service lines are constructed using the same trench. However, two service lines could be constructed initially, while the remaining service line is constructed at another time. Constructing service lines in this manner would allow at least one lane of traffic to be maintained on Tafts Avenue.

Table 6 also illustrates the effect service line location will have on traffic lane routing. Moving service lines two feet closer to the roadway centerline reduces cartway width difference values by two feet, resulting in traffic routing lane loss for Revere Street between Highland Avenue and Summit Street, Winthrop Shore Drive between Beacon Street and Grovers Lane, and Washington Avenue between Veterans Road and Shirley Street. Truck use during construction would be precluded on Shirley Street between Petrel Street and Bayview Street, and Tewksbury Street and Terrace Avenue as well as along Tafts Avenue. Shirley Street is part of the Deer Island truck route at these locations.

Curbside parking space along service line roadways is used most heavily in commercial areas and some residential sections. Businesses may be adversely affected by the temporary loss of near-by parking. However, parking will be disrupted along a given roadway for no more than 600-ft. Table 7 lists the roadway sections where curbside parking has a greater than 50 percent capacity use; parking has the highest probability of disruption in these areas.

Table 7

Curbside Park Use Greater Than 50 Percent

STREET	CROSS STREET ONE	CROSS STREET TWO	AREA TYPE	ROADWAY LENGTH (ft)	OBSERVATION 1 SIDE A PARKING YES/NO	OBSERVATION 1 SIDE A % PRKNG	OBSERVATION 1 SIDE B PARKING YES/NO	OBSERVATION 1 SIDE B % PRKNG	OBSERVATION 2 SIDE A % PRKNG	OBSERVATION 2 SIDE B % PRKNG
REVERE	Upland	Highland	R		Yes	15%	Yes	0%	25%	50%
	Summit	Shirley	R/C	528.0	Yes	10%	Yes	60%	5%	20%
CREST	Grovers	Highland	C	1056.0	N		Y	80%		95%
LOCUST	Revere	Wnthrp Shr	R		Yes	50%	Yes	50%	40%	40%
VETERANS	Washington	Hadassah	R/C	5544.0	Yes	75%	No		50%	
SHIRLEY	Washington	Tewksbury	C	528.0	Yes	75%	Yes	90%	75%	95%
	Tewksbury	Terrace	R/C	792.0	No		Yes	90%		95%
TAFTS	Shirley	Elliot	R/C	264	No		Yes	80%		25%
WINTHROP	Crescent	Bennington	R	950.4	Y	95%	Y	95%	95%	95%
BROADWAY	Rt 16 On Rm	Eastern Ave	C	1584.0	Y	40%	Y	40%	98%	98%
EASTERN AV	Broadway	Louis	C/R	1320.0	Y	85%	Y	85%	95%	95%
SHELBY	Lexington	Saratoga	C/R	475.2	Y	95%	Y	95%	100%	100%
SARATOGA	Shelby	Neptune	C/R	528.0	Y	100%	Y	100%	100%	100%
NEPTUNE	Saratoga	Bennington	C	158.4	Y	95%	Y	95%	100%	100%
	Bennington	Frankfurt	R	369.6	N		Y	50%		0%
BENNINGTON	Neptune	Trident	C/R	6072.0	Y	80%	Y	80%	80%	80%
K STREET	E 1st	Broadway	R	792.0	Y	85%	Y	85%	100%	100%
E.BROADWAY	K	L	C	686.4	Y	95%	Y	95%	90%	90%
	L	Farragut	R	3432.0	Y	90%	Y	90%	90%	90%
	Farragut	Wm J Day		105.6	Y	90%	Y	90%	90%	90%
WM J DAY	Broadway	Ft IndpndceOcean		3432.0	N		Y	30%		90%

Table 8 presents hourly roadway volumes along the proposed service line routes. Principal arterial roadways such as Revere Beach Parkway and Bennington Street exhibit the greatest peak volumes of traffic. The paragraphs below discuss the roadways in more detail by locality.

Three roadways are affected in South Boston. These are William J. Day Boulevard, Broadway and K Street (Route S-2). William J. Day Boulevard is an ocean view drive to Fort Independence that provides public access to Pleasure Bay. As a consequence, there is heavy use of parking wherever allowed. Broadway and K Street are bordered primarily by high density residential housing. Parking is also heavily used on these streets. Bi-directional traffic can be maintained on all three roadways; at least three lanes are available on both Broadway and William J. Day Boulevard, and two lanes on K Street. Peak hourly traffic volumes are respectively 900, 1600 and 200 vehicles per hour.

Two roadways are affected in Revere -- Winthrop Avenue (Routes N-1 through N-1d) and Revere Beach Parkway (Routes N-1 through N-1d). Revere Beach Parkway is the main east-west arterial through Revere and supports three lanes of traffic in each direction. The north-south segment south of Winthrop Parkway is part of the north access route to Winthrop, the east-west segment east of Bennington Street is bordered by high density residential housing, and the segment west of Bennington Street turns into Revere Beach Parkway. Only one direction of traffic will be affected by construction on Revere Beach Parkway, and at least two lanes of traffic can be maintained around construction. Bi-directional traffic can be supported on all segments of Winthrop Avenue.

Four roadways are affected by roadway construction in East Boston -- Shelby Street, Saratoga Street, Neptune Street and Bennington Street (Route N-3). Shelby Street is a small one-way residential street resulting in minimal traffic impact. Saratoga Street and Neptune Street are also relatively minor roadways while Bennington Street is a southwest-northeast

Table 8
Roadway Peak Hourly Vehicle Volumes

Street	Location	Drtn	Pk Vlm	Time	Drtn	Pk Vlm	Time	Drtn	Pk Vlm	Time	Lanes Around Construction
Wm J. Day Blvd btwn I & K	S. Boston	EB	1050	7 AM	WB	1075	3 PM	T	1600	6 PM	Three
K St N of Broadway	S. Boston	NB	60	3 PM	SB	165	4 PM	T	200	4 PM	Four
Broadway E of K	S. Boston	EB	365	2 PM	WB	550	3 PM	T	900	3 PM	Two
Revere Bch Pkwy E of NE Xpres	Revere	EB	1650	4 PM	WB	2950	5 PM	T	4500	5 PM	Two
Revere Bch Pkwy E of N. Shore	Revere	EB	1400	12 PM	WB	1150	8 AM	T	2400	12 PM	Two
Winthrop Av W of Bennington	Revere	NB	800	6 PM	SB	500	4 PM	T	1300	5 PM	Two
Winthrop Av * W of Wn Pkwy	Revere							T	414	5 PM	Two
Winthrop Av * S of Wn Prk	Revere							T	1426	5 PM	Two
Bennington St N of Neptune	E. Boston	EB	970	8 AM	WB	650	4 PM	T	1325	4 PM	Five
Neptune E of Saratoga	E. Boston	EB	600	8 AM	WB	550	5 PM	T	950	5 PM	Six
Saratoga S of Neptune	E. Boston	-	-	-	WB	200	7 AM	T	200	7 AM	Four
Eastern * S of Broadway	Chelsea							T	602	5 PM	Three
Broadway * N of Eastern	Chelsea							T	1228	5 PM	Three
Eastern * N of Marginal	Chelsea							T	1031	5 PM	Four
Marginal * W of Eastern	Chelsea							T	325	5 PM	Three
Crest *	Winthrop							T	644	5 PM	One
Revere * W of Crest	Winthrop							T	617	5 PM	One
Revere * N of Crest	Winthrop							T	1280	5 PM	Two
Shirley * S of Revere	Winthrop							T	455	5 PM	One
Veterans * S of Shirley	Winthrop							T	297	5 PM	One
Washington * E of Veterans	Winthrop							T	702	5 PM	Two
Shirley * S of Washington	Winthrop							T	579	5 PM	One
Tafts S of Elliot	Winthrop	SB	80	2 PM	NB	211	12 PM	T	286	12 PM	One
Winthrop Shore Sat Cnt	Winthrop	NB	302	11 PM	SB	378	12 PM	T	633	12 PM	Two
Winthrop Shore PkHrWk	Winthrop							T	678	5 PM	Two

Table 8
Roadway Peak Hourly Vehicle Volumes

Street	Location	Drtn	Pk Vlm	Time	Drtn	Pk Vlm	Time	Drtn	Pk Vlm	Time	Lanes Around Construction
Wm J. Day Blvd btwn I & K	S. Boston	EB	1050	7 AM	WB	1075	3 PM	T	1600	6 PM	Three
K St N of Broadway	S. Boston	NB	60	3 PM	SB	165	4 PM	T	200	4 PM	Four
Broadway E of K	S. Boston	EB	365	2 PM	WB	550	3 PM	T	900	3 PM	Two
Revere Bch Pkwy E of NE Xpres	Revere	EB	1650	4 PM	WB	2950	5 PM	T	4500	5 PM	Two
Revere Bch Pkwy E of N. Shore	Revere	EB	1400	12 PM	WB	1150	8 AM	T	2400	12 PM	Two
Winthrop Av W of Bennington	Revere	NB	800	6 PM	SB	500	4 PM	T	1300	5 PM	Two
Winthrop Av * W of Wn Pkwy	Revere							T	414	5 PM	Two
Winthrop Av * S of Wn Prk	Revere							T	1426	5 PM	Two
Bennington St N of Neptune	E. Boston	EB	970	8 AM	WB	650	4 PM	T	1325	4 PM	Five
Neptune E of Saratoga	E. Boston	EB	600	8 AM	WB	550	5 PM	T	950	5 PM	Six
Saratoga S of Neptune	E. Boston	-	-	-	WB	200	7 AM	T	200	7 AM	Four
Eastern * S of Broadway	Chelsea							T	602	5 PM	Three
Broadway * N of Eastern	Chelsea							T	1228	5 PM	Three
Eastern * N of Marginal	Chelsea							T	1031	5 PM	Four
Marginal * W of Eastern	Chelsea							T	325	5 PM	Three
Crest *	Winthrop							T	644	5 PM	One
Revere * W of Crest	Winthrop							T	617	5 PM	One
Revere * N of Crest	Winthrop							T	1280	5 PM	Two
Shirley * S of Revere	Winthrop							T	455	5 PM	One
Veterans * S of Shirley	Winthrop							T	297	5 PM	One
Washington * E of Veterans	Winthrop							T	702	5 PM	Two
Shirley * S of Washington	Winthrop							T	579	5 PM	One
Tafts S of Elliot	Winthrop	SB	80	2 PM	NB	211	12 PM	T	286	12 PM	One
Winthrop Shore Sat Cnt	Winthrop	NB	302	11 PM	SB	378	12 PM	T	633	12 PM	Two
Winthrop Shore PkHrWk	Winthrop							T	678	5 PM	Two

arterial between East Boston and southeast Revere. At least five lanes of traffic could be maintained along Bennington Street if parking was disallowed. The affected Neptune Street and Saratoga Street segments are wide and can respectively support six and four lanes of traffic during construction.

Three roadways in Chelsea are affected by service line construction -- Broadway (Routes N-1 through N-1d), Eastern Avenue (Routes N-1 through N-1d), and Marginal Street (Route N-2). Use along the roadways is commercial and industrial. All three roadways are between 37-ft and 53-ft in width; at least three lanes of traffic can be maintained along each roadway.

Five service line routes (Routes N-1, N-1a, N-1b, N-1c, N-1d) have been proposed through Winthrop. The possible affected roadways are Revere Street, Crest Avenue, Winthrop Shore Drive, Veterans Road and Tafts Avenue. Locust Street, Tewksbury Street and Adams Street could also be impacted; however, these roadways are secondary residential streets resulting in minimal traffic impacts.

Revere Street north of Crest Avenue is a segment of all five routes and is one of only two access routes into Winthrop. The other access is Saratoga Street on the west side of Winthrop. Crest Avenue is part of two routes (Routes N-1 and N-1c), is fairly narrow, and is bordered by local commercial businesses. Crest Avenue could be avoided by routing the route along Revere Street west of Crest Avenue then southeast on Locust Avenue to Winthrop Shore Drive (Route N-1a and N-1d). Winthrop Shore Drive borders Broad Sound between Crest Avenue and Moore Street where it terminates. The route would then either continue cross-country (Routes N-1a and N-1d) to Deer Island (Route N-1c) or would turn west on Tewksbury Street to Shirley Street and Tafts Avenue to avoid construction along the beach. Crest Avenue is part of Route N-1c.

Shirley Street south of Washington Avenue turns into Tafts Avenue through Shirley Point; these roadways comprise the only access between Deer Island and the mainland. As a consequence, these roadways are also part of the truck route (Routes N-1b, N-1c and N-1d).

Route N-1b travels through Winthrop along a segment of Shirley Street between Revere and Veterans Road, Veterans Road between Shirley Street and Washington Avenue and a very short segment of Washington Avenue that connects Veterans Road and Shirley Street. The route then continues down Shirley Street and Tafts Avenue to Deer Island. These roadways are part of the designated truck route through Winthrop to Deer Island.

Affected roadway peak hour vehicle volumes averaged 550 per hour in Winthrop. Tafts Avenue exhibited a peak roadway volume of 286 vehicles per hour; peak traffic on Revere Street north of Crest Avenue was 1280 vehicles per hour.

Service line routes through Winthrop could be comprised of electric power, gas and potable water or gas and potable water should another proposed route for interim and permanent electric power be selected.

At least one lane can be maintained for routing vehicles around service line construction for the majority of affected roadways. Traffic on these roadways is relatively light; bi-directional traffic could be accomodated provided that flag-workers are stationed at each end of the construction zone to assist in safe, smooth traffic routing.

Tafts Avenue between Shirley Street and the beginning of the Deer Island causeway sea wall is too narrow for even one traffic lane to be kept free should electric power, gas and water service lines be constructed in a common trench. Vehicles must be detoured around construction by using adjacent and equally narrow residential roadways. Tafts Avenue is approximately 1,865-ft long; about 800-ft of service line can be located out of the roadway in the unimproved land between Deer Island and Adams Street provided that land use arrangements with the Commonwealth of Massachusetts are possible. Alternately, the service lines could be constructed in the roadway, and traffic could be routed using a temporary roadway constructed on the adjacent land.

The rest of Tafts Avenue would be closed to traffic during service line construction, rendering Deer Island inaccessible. Construction will continue for at least eight days. Impacts to traffic would be in only one direction for the 265-ft section between Shirley and Elliot Streets. The roadway is one-way northbound along this section. Constructing only two services lines in a common trench would allow one lane of traffic to be maintained along Tafts Avenue. The third service line would either be constructed prior to or after the above construction.

Field observations have shown that running speeds in Winthrop average 25 mph. However, service line construction will require drivers to travel at slower speeds through the work area. On average, vehicles decelerate at 4 miles per hour per second and accelerate at 2 miles per hour per second.

With the above rates, there would be a need for approximately 130 feet to reduce speed from 25 miles per hour (mph) to 10 mph, and approximately 240 feet to recover 25 mph. A sign requiring the reduced speed would require placement at least 500-ft in advance of the construction zone for approaching vehicles; the acceleration back to 25 mph would require no more than an extra 6 seconds for someone negotiating the required distances at 25 mph.

The delay associated solely with reducing and then recovering speed is small. The transition from 25 mph down to 10 mph and then back to 25 mph would require no more than an extra 6 seconds for someone negotiating the required distances at 25 mph.

Most delay is associated with slow speed running which is dependent on the volume of traffic present as well as on the length of construction zone after accounting for the portion not required for deceleration and acceleration. If the length of slow speed running were 1000 feet, total delay per vehicle would be approximately 44 seconds, measured against the time need to cover the total distance at 25 mph. Given an overall trip length of 5 miles, total trip time would only be increased by approximately 6 percent.

Marine Construction

Submarine construction for the electric power service lines requires construction across Boston Harbor. Construction will bisect Presidents Road, one of the two major navigation channels serving Boston Harbor. The designated anchorage area used by most of the commercial shipping traffic requiring anchorage located between Logan Airport and Deer Island will not be affected.

Commercial cargo ships, tankers, passenger liners, local passenger ferries and sightseeing craft all operate within Boston Harbor. Table 9 presents a record of inbound vessels using the Port of Boston from 1972 to 1985. On average, approximately 88 percent of the vessels using Boston Harbor have drafts of 18-ft or less. Approximately 1200 vessels per year with drafts greater than 18-ft enter the Harbor.

Table 10 lists the total yearly volumes and types of vessels that arrived at either the Massachusetts Port Authority (Massport) the Moran Container Terminal in Charlestown, Harbor Gateway Terminal in South Boston or Conley Terminal in South Boston in 1986 and 1987.

Data were obtained from Massport and the United States Coast Guard that showed daily arrivals respectively for large draft vessels using Massport Port of Boston facilities and container ships with cargo greater than 1600 tons. These data are summarized by month in Table 11. According to Massport data, the maximum daily number of large vessels entering Boston Harber was 9 in January and March 1987. According to Coast Guard data, the maximum daily vessel arrival number was 7.

Local sightseeing cruises and passenger ferry services operate from piers on the downtown Boston waterfront to destinations at Logan Airport, Hull, Hingham, the Boston Harbor Island State Park and whale watching destinations. The commercial fishing fleet berthed in Boston Harbor consists of 78 dragger and gillnet vessels harvesting finfish, 1 vessel harvesting sea clams and 127 inshore lobster boats.

Table 9

Boston Harbor Yearly Vessel Arrivals 1972-1985

Historical Record of Trips and Drafts
of Vessels (Inbound Only) Using the Port of Boston
Number of Trips Per Year

Draft (ft)	1985	1984	1983	1982	1981	1980	1979	1978	1977	1976	1975	1974	1973	1972	Aug
41	0									3	1	2	1		
40	3	4	3	1	2	5	20	30	19	12	15	15	18	16	
39	7	5	2		4	20	26	40	36	41	41	25	56	41	
38	24	23	16	18	17	25	56	29	36	58	31	45	32	39	
37	29	22	13	17	42	21	43	29	55	45	43	44	41	39	
36	36	61	35	33	46	49	57	59	67	49	60	46	55	47	
35	47	61	44	56	77	77	69	87	69	57	55	58	62	69	
34	30	31	67	66	62	59	100	81	78	55	64	52	57	57	
33	33	17	21	36	37	37	52	57	85	59	55	44	80	57	
32	17	22	33	36	29	24	39	37	72	70	73	73	88	85	
31	31	33	40	35	36	43	49	33	70	81	56	69	91	98	
30	59	62	58	66	72	39	43	48	49	46	51	77	65	55	
29	31	51	73	67	74	58	43	31	37	42	36	45	78	44	
28	47	45	48	71	74	76	67	56	73	50	52	55	60	62	
27	76	61	62	104	82	74	101	90	94	70	70	91	95	72	
26	66	49	61	75	81	79	99	105	101	104	84	98	96	103	
25	97	65	40	72	54	57	73	92	56	79	72	85	88	97	
24	55	48	80	75	69	76	70	80	54	95	95	80	76	95	
23	65	63	51	76	71	58	47	39	40	49	69	63	85	118	
22	75	91	80	47	46	30	40	40	44	48	58	75	78	118	
21	65	79	31	35	13	36	32	51	37	43	50	43	75	83	
20	56	64	71	56	34	36	44	38	25	45	44	49	82	66	
19	65	42	41	52	57	40	37	45	43	36	23	30	54	62	
18 & Less	5,885	5,034	4,936	5,050	7,592	7,157	8,248	12,679	17,916	15,000	12,048	12,725	10,710	11,543	
19 or Grtr	1,014	999	970	1,094	1,079	1,019	1,207	1,197	1,240	1,237	1,198	1,264	1,513	1,523	1,182
TOTAL	6,899	6,033	5,906	6,144	8,671	8,176	9,455	13,876	19,156	16,237	13,246	13,989	12,223	13,066	
%19 or greater	14.7%	16.7%	16.4%	17.8%	12.4%	12.5%	12.8%	8.6%	6.5%	7.6%	9.0%	9.0%	12.4%	11.7%	12.0%

Source: USACOE 1986 and Previous Editions; USACOE, 1987

Reference: "Draft Supplemental Environmental Impact Statement - Boston Harbor Co

The majority of local cruise and commuter ferry enterprises are operated from Rowes Wharf and Long Wharf. Table 12 presents cruise and commuter schedules for Massachusetts Bay Lines, Boston Harbor Commuter Service, Boston Harbor Cruises and Baystate Cruises. In general, cruises are scheduled daily from Memorial Day to Labor Day and weekends from Labor Day to Memorial Day when weather permits. Local cruise and commuter vessels and the above described commercial fishing fleet usually have drafts of 18-ft or less.

It is expected that submarine construction will occur outside of President's Road; however, cable construction will have to bisect the channel at least at one point. Channel crossing would require either 2 or 14 construction days depending on how much rock is present at the crossing point. At most, 600-ft of the channel width would be occupied by the construction barge; most vessels using Boston Harbor could still pass around construction using the 600-ft of available channel. Shallow draft vessels also would not be constrained by Harbor soundings depths to travel in the navigation channel. It is estimated that, at most, the channel could be unavailable for use for approximately 8 construction days.

Table 10

MASSPORT Port of Boston Arrivals

Vessel Type	1987	1986
Tankers	315	374
Full Container Vessels	248	215
Container Feeder Barges	184	192
General Cargo Vessels	89	85
Dry Bulk	81	82
Passenger Vessels	23	19
Other	11	7
	951	974

Source: Massachusetts Port Authority

Table 11
Monthly Vessel Arrivals

	Massport* Arrival	Coast Guard* Port of Boston Arrival	Anchorage Arrival
January	64	73	11
February	63	58	12
March	74	59	7
April	58	43	9
May	59	49	10
June	67	79	6
July	59	56	4
August	65	57	3
September	58	64	10
October	64	54	1
November	51	56	2
December	78	84	5
	760	732	80
Monthly Avg	63	61	7

* January 1987-December 1987 data.
** April 1987-March 1988 data.

Source: Massachusetts Port Authority
United States Coast Guard

Table 12
Cruise and Commuter Ferry Schedules

ROWES WHARF

1) Massachusetts Bay Lines -
   Labor Day to Memorial Day:
      Daily to Harbor - 10:00 AM, 12:00 PM, 2:00 PM
      Daily to Georgia Island - 10:00 AM, 12:30 PM, 3:00 PM
      Daily to Hingham - 10:00 AM, 12:30 PM, 3:00 PM

   Year Round:
      Commuter Boat between Hingham and Rowes Wharf
         Leaves Hingham - 7:10 AM
         Leaves Boston - 5:10 PM

2) Boston Harbor Commuter Service -
   Year Round:
      Between Boston and Hingham
         Leaves Hingham -
         AM: 6:00, 6:50, 7:10, 7:20, 7:40, 8:00, 8:10, 8:40
         PM: 4:20, 5:00, 5:15, 6:10

         Leaves Boston -
         AM: 6:35, 7:25, 8:00
         PM: 3:45, 4:20, 4:40, 5:10, 5:20, 5:30 6:00, 6:20, 7:00

LONG WHARF

1) Boston Harbor Cruises -
   Memorial Day to Labor Day: Daily
   Labor Day to Memorial Day: Weekends

Historic	- 11:00 AM, 1:00 PM, 3:00 PM
Constitution	- Every hour on the 1/2 hr: 10:30 AM to 4:30 PM
Islands	- Every 2 hours between 10:00 AM and 4:00 PM
Luncheon	- 12:10 PM, 1:10 PM
Sunset	- 1 per evening
Charters	- 3 or 4 per night

2) Daily Commuter Shuttle -
   To Constitution Wharf:
      6:30 AM, 7:20 AM, 8:40 AM, 4:05 PM, 4:45 PM, 5:35 PM

   To Charlestown Navy Yard:
      7:00 AM, 7:40 AM, 8:20 AM, 9:30 AM, 4:25 PM, 5:15 PM, 5:30 PM

3) Baystate Cruises*
   Sunset Cruise: 5:00 PM, Peddock's Island: 10:00 AM, Dinner Cruise: 7:30 PM, Provincetown: 9:30 AM, Martha's Vineyard: 8:45 AM, Whale Watch: 8:30 AM, 9:00 AM, Nantasket Beach: 10:00 AM, 1:00 PM, 5:30 PM, Inner Harbor: every hour on the half, Outer Harbor: 10:00 AM, 1:00 PM, 2:00 PM, 3:00 PM

*Cruises also depart from Commonwealth Pier and U.S.S. Constitution Pier.

SECONDARY TREATMENT FACILITIES PLAN
SUPPLEMENT TO APPENDIX H, VOLUME III

APPENDIX B

SEDIMENT ANALYTICAL REPORTS

FINAL REPORT

Stone & Webster
Boston, Mass.

E3I Project No.: 880087

P. O. Number:

Prepared by:

Dr. Charles C. Wohlers
Directory, Inorganic Laboratories
Energy & Environmental Engineering, Inc.

Date Prepared: 27 May 1988

TABLE OF CONTENTS

I. INTRODUCTION

This report summarizes results of analyses on Boston Harbor core samples received by E3I from Stone & Webster 10 May 1988. Analytical methods employed for these analyses are described in Section II, and the results are presented in Section III. Sections IV and V contain Quality Control and Quality Assurance Information.

SAMPLE ID REFERENCE

E3I ID	Client ID
8008701	S-1
8008702	S-2
8008703	S-3
8008704	S-4
8008705	S-5
8008706	S-6
8008707	S-7
8008708	S-8
8008709	S-9
8008710	S-10
8008711	N-1
8008712	N-2
8008713	N-3
8008714	N-4
8008715	N-5
8008716	N-6
8008717	N-7
8008718	N-8
8008719	N-9
8008720	N-10

II.METHOD SUMMARY

For metals analyses, two sample preparation methods were used. The first, EPA Method 200.7, Section 9.3, was used for all ICP analyses. Briefly, the sample is digested twice to near dryness with two portions of nitric acid. Next, HCl and water are added with further heating, the volume is adjusted, and the sample filtered. For furnace analyses a similar sample preparation method was followed where the HCl was omitted.

The following elements were analyzed by ICP on a Perkin-Elmer 6500XR:

Cr	Cu	Pb
Ni	V	Zn

These elements were analyzed in accordance with EPA Method 200.7.

The following elements were analyzed by Zeeman Graphite Furnace Atomic Absorption using a Perkin-Elmer 5100 AA in accordance with the appropriate EPA Methods:

As	Cd	Pb

Lead was analyzed by Graphite Furnace AA for samples with concentrations below 65ug/L; ICP for concentrations above that.

Mercury was analyzed by the cold vapor method, EPA 245.1, on a modified Perkin-Elmer 303 AA.

III. RESULTS

Final analytical values for the samples analyzed are given on the following pages. For metal analyses, a value given in brackets indicates that it is close to the detection limit, and therefore its uncertainty is relatively large. If an element was not detected, the value is given as less than the element's detection limit.

E N E R G Y   A N D   E N V I R O N M E N T A L   E N G I N E E R I N G

INORGANIC ANALYSIS DATA SHEET

CLIENT: Stone & Webster

CLIENT SAMPLE ID NO.:

S-1

E3I SAMPLE ID NO.: 88008701

Date Received: 05/10/88
Date Prepared: 05/20/88

Matrix: SOIL
% Solids: 63.0

Elements Identified and Measured

Concentrations in mg/kg dry weight

Arsenic	16
Cadmium	[2]
Chromium	83
Copper	145
Lead	135
Mercury	[0.6]
Nickel	38
Vanadium	95
Zinc	227

Comments:
"<" means that the element was not detected and that its concentration is less than the indicated value. A value in brackets indicates a concentration within five times the detection limit and therefore of lower precision.

Lab Manager: Chal Wohler

E N E R G Y   A N D   E N V I R O N M E N T A L   E N G I N E E R I N G

INORGANIC ANALYSIS DATA SHEET

CLIENT: Stone & Webster

CLIENT SAMPLE ID NO.: S-2

E3I SAMPLE ID NO.: 88008702

Date Received: 05/10/88
Date Prepared: 05/20/88

Matrix: SOIL
% Solids: 71.5

Elements Identified and Measured

Concentrations in mg/kg dry weight

Arsenic	9.5
Cadmium	<0.8
Chromium	61
Copper	79
Lead	62
Mercury	[0.6]
Nickel	19
Vanadium	39
Zinc	128

Comments:
"<" means that the element was not detected and that its concentration is less than the indicated value. A value in brackets indicates a concentration within five times the detection limit and therefore of lower precision.

Lab Manager: Charles Holden

E N E R G Y   A N D   E N V I R O N M E N T A L   E N G I N E E R I N G

INORGANIC ANALYSIS DATA SHEET

CLIENT: Stone & Webster

CLIENT SAMPLE ID NO.: S-3

E3I SAMPLE ID NO.: 88008703

Date Received: 05/10/88
Date Prepared: 05/20/88

Matrix: SOIL
% Solids: 51.0

Elements Identified and Measured

Concentrations in mg/kg dry weight

Arsenic	14
Cadmium	[4]
Chromium	266
Copper	154
Lead	138
Mercury	1.4
Nickel	31
Vanadium	82
Zinc	277

Comments:
"<" means that the element was not detected and that its concentration is less than the indicated value. A value in brackets indicates a concentration within five times the detection limit and therefore of lower precision.

Lab Manager: ______

E N E R G Y   A N D   E N V I R O N M E N T A L   E N G I N E E R I N G

INORGANIC ANALYSIS DATA SHEET

CLIENT: Stone & Webster

CLIENT SAMPLE ID NO.: S-4

E3I SAMPLE ID NO.: 88008704

Date Received: 05/10/88
Date Prepared: 05/20/88

Matrix: SOIL
% Solids: 71.0

Elements Identified and Measured

Concentrations in mg/kg dry weight

Arsenic	10
Cadmium	<0.8
Chromium	52
Copper	37
Lead	26
Mercury	<0.1
Nickel	29
Vanadium	50
Zinc	90

Comments:
"<" means that the element was not detected and that its concentration is less than the indicated value. A value in brackets indicates a concentration within five times the detection limit and therefore of lower precision.

Lab Manager: [signature]

E N E R G Y   A N D   E N V I R O N M E N T A L   E N G I N E E R I N G

INORGANIC ANALYSIS DATA SHEET

CLIENT: Stone & Webster

CLIENT SAMPLE ID NO.: S-5

E3I SAMPLE ID NO.: 88008705

Date Received: 05/10/88
Date Prepared: 05/20/88

Matrix: SOIL
% Solids: 62.0

Elements Identified and Measured

Concentrations in mg/kg dry weight

Arsenic	9.4
Cadmium	<0.9
Chromium	76
Copper	50
Lead	46
Mercury	0.80
Nickel	22
Vanadium	45
Zinc	109

Comments:
"<" means that the element was not detected and that its concentration is less than the indicated value. A value in brackets indicates a concentration within five times the detection limit and therefore of lower precision.

Lab Manager: Charles Holden

E N E R G Y   A N D   E N V I R O N M E N T A L   E N G I N E E R I N G

INORGANIC ANALYSIS DATA SHEET

CLIENT: Stone & Webster

CLIENT SAMPLE ID NO.: S-6

E3I SAMPLE ID NO.: 88008706

Date Received: 05/10/88
Date Prepared: 05/20/88

Matrix: SOIL
% Solids: 74.0

Elements Identified and Measured

Concentrations in mg/kg dry weight

Arsenic	3.7
Cadmium	<0.7
Chromium	20
Copper	6.2
Lead	5.3
Mercury	<0.1
Nickel	[5]
Vanadium	22
Zinc	32

Comments:
"<" means that the element was not detected and that its concentration is less than the indicated value. A value in brackets indicates a concentration within five times the detection limit and therefore of lower precision.

Lab Manager: [signature]

E N E R G Y   A N D   E N V I R O N M E N T A L   E N G I N E E R I N G

INORGANIC ANALYSIS DATA SHEET

CLIENT: Stone & Webster

E3I SAMPLE ID NO.: 88008707

CLIENT SAMPLE ID NO.:

S-7

Date Received: 05/10/88
Date Prepared: 05/20/88

Matrix: SOIL
% Solids: 65.0

Elements Identified and Measured

Concentrations in mg/kg dry weight

Arsenic	9.0
Cadmium	<0.9
Chromium	54
Copper	33
Lead	31
Mercury	<0.1
Nickel	22
Vanadium	43
Zinc	84

Comments:
"<" means that the element was not detected and that its concentration is less than the indicated value. A value in brackets indicates a concentration within five times the detection limit and therefore of lower precision.

Lab Manager:

ENERGY AND ENVIRONMENTAL ENGINEERING

INORGANIC ANALYSIS DATA SHEET

CLIENT: Stone & Webster

CLIENT SAMPLE ID NO.: S-8

E3I SAMPLE ID NO.: 88008708

Date Received: 05/10/88
Date Prepared: 05/20/88

Matrix: SOIL
% Solids: 62.0

Elements Identified and Measured

Concentrations in mg/kg dry weight

Arsenic	8.7
Cadmium	[3]
Chromium	241
Copper	109
Lead	92
Mercury	[0.3]
Nickel	17
Vanadium	50
Zinc	204

Comments:
"<" means that the element was not detected and that its concentration is less than the indicated value. A value in brackets indicates a concentration within five times the detection limit and therefore of lower precision.

Lab Manager:

E N E R G Y   A N D   E N V I R O N M E N T A L   E N G I N E E R I N G

INORGANIC ANALYSIS DATA SHEET

CLIENT: Stone & Webster

CLIENT SAMPLE ID NO.: S-9

E3I SAMPLE ID NO.: 88008709

Date Received: 05/10/88
Date Prepared: 05/20/88

Matrix: SOIL
% Solids: 68.0

Elements Identified and Measured

Concentrations in mg/kg dry weight

Arsenic	3.5
Cadmium	<0.8
Chromium	22
Copper	7.8
Lead	6.3
Mercury	<0.1
Nickel	[8]
Vanadium	22
Zinc	34

Comments:
"<" means that the element was not detected and that its concentration is less than the indicated value. A value in brackets indicates a concentration within five times the detection limit and therefore of lower precision.

Lab Manager: Charles Wohlers

E N E R G Y   A N D   E N V I R O N M E N T A L   E N G I N E E R I N G

INORGANIC ANALYSIS DATA SHEET

CLIENT: Stone & Webster

CLIENT SAMPLE ID NO.: S-10

E3I SAMPLE ID NO.: 88008710

Date Received: 05/10/88
Date Prepared: 05/20/88

Matrix: SOIL
% Solids: 68.0

Elements Identified and Measured

Concentrations in mg/kg dry weight

Arsenic	3.7
Cadmium	<0.8
Chromium	22
Copper	8.9
Lead	6.1
Mercury	<0.2
Nickel	[11]
Vanadium	24
Zinc	35

Comments:
"<" means that the element was not detected and that its concentration is less than the indicated value. A value in brackets indicates a concentration within five times the detection limit and therefore of lower precision.

Lab Manager: ____________

E N E R G Y   A N D   E N V I R O N M E N T A L   E N G I N E E R I N G

INORGANIC ANALYSIS DATA SHEET

CLIENT: Stone & Webster

CLIENT SAMPLE ID NO.: N-1

E3I SAMPLE ID NO.: 88008711

Date Received: 05/10/88
Date Prepared: 05/20/88

Matrix: SOIL
% Solids: 50.0

Elements Identified and Measured

Concentrations in mg/kg dry weight

Arsenic	12
Cadmium	[4]
Chromium	224
Copper	133
Lead	103
Mercury	[0.7]
Nickel	35
Vanadium	71
Zinc	239

Comments:
"<" means that the element was not detected and that its concentration is less than the indicated value. A value in brackets indicates a concentration within five times the detection limit and therefore of lower precision.

Lab Manager: Charles Walters

E N E R G Y   A N D   E N V I R O N M E N T A L   E N G I N E E R I N G

INORGANIC ANALYSIS DATA SHEET

CLIENT SAMPLE ID NO.: N-2

CLIENT: Stone & Webster

E3I SAMPLE ID NO.: 88008712

Date Received: 05/10/88
Date Prepared: 05/20/88

Matrix: SOIL
% Solids: 72.0

Elements Identified and Measured

Concentrations in mg/kg dry weight

Arsenic	6.0
Cadmium	[0.7]
Chromium	65
Copper	40
Lead	35
Mercury	[0.2]
Nickel	[7]
Vanadium	31
Zinc	85

Comments:
"<" means that the element was not detected and that its concentration is less than the indicated value. A value in brackets indicates a concentration within five times the detection limit and therefore of lower precision.

Lab Manager: [signature]

E N E R G Y   A N D   E N V I R O N M E N T A L   E N G I N E E R I N G

INORGANIC ANALYSIS DATA SHEET

CLIENT: Stone & Webster

CLIENT SAMPLE ID NO.: N-3

E3I SAMPLE ID NO.: 88008713

Date Received: 05/10/88
Date Prepared: 05/20/88

Matrix: SOIL
% Solids: 57.0

Elements Identified and Measured

Concentrations in mg/kg dry weight

Arsenic	9.0
Cadmium	<1
Chromium	51
Copper	26
Lead	18
Mercury	<0.1
Nickel	22
Vanadium	56
Zinc	75

Comments:
"<" means that the element was not detected and that its concentration is less than the indicated value. A value in brackets indicates a concentration within five times the detection limit and therefore of lower precision.

Lab Manager: [signature]

E N E R G Y   A N D   E N V I R O N M E N T A L   E N G I N E E R I N G

INORGANIC ANALYSIS DATA SHEET

CLIENT SAMPLE ID NO.:

CLIENT: Stone & Webster

N-4

E3I SAMPLE ID NO.: 88008714

Date Received: 05/10/88
Date Prepared: 05/20/88

Matrix: SOIL
% Solids: 62.0

Elements Identified and Measured

Concentrations in mg/kg dry weight

Arsenic	8.0
Cadmium	<0.9
Chromium	44
Copper	28
Lead	18
Mercury	<0.2
Nickel	22
Vanadium	46
Zinc	72

Comments:
"<" means that the element was not detected and that its concentration is less than the indicated value. A value in brackets indicates a concentration within five times the detection limit and therefore of lower precision.

Lab Manager: [signature]

E N E R G Y   A N D   E N V I R O N M E N T A L   E N G I N E E R I N G

INORGANIC ANALYSIS DATA SHEET

CLIENT: Stone & Webster

CLIENT SAMPLE ID NO.: N-5

E3I SAMPLE ID NO.: 88008715

Date Received: 05/10/88
Date Prepared: 05/20/88

Matrix: SOIL
% Solids: 65.0

Elements Identified and Measured

Concentrations in mg/kg dry weight

Arsenic	7.0
Cadmium	<0.9
Chromium	32
Copper	21
Lead	13
Mercury	<0.09
Nickel	[12]
Vanadium	38
Zinc	54

Comments:
"<" means that the element was not detected and that its concentration is less than the indicated value. A value in brackets indicates a concentration within five times the detection limit and therefore of lower precision.

Lab Manager: [signature]

E N E R G Y   A N D   E N V I R O N M E N T A L   E N G I N E E R I N G

INORGANIC ANALYSIS DATA SHEET

CLIENT SAMPLE ID NO.:

N-6

CLIENT: Stone & Webster

E3I SAMPLE ID NO.: 88008716

Date Received: 05/10/88
Date Prepared: 05/20/88

Matrix: SOIL
% Solids: 62.0

Elements Identified and Measured

Concentrations in mg/kg dry weight

Arsenic	10
Cadmium	<0.9
Chromium	50
Copper	35
Lead	22
Mercury	<0.09
Nickel	25
Vanadium	52
Zinc	78

Comments:
"<" means that the element was not detected and that its concentration is less than the indicated value. A value in brackets indicates a concentration within five times the detection limit and therefore of lower precision.

Lab Manager:

E N E R G Y   A N D   E N V I R O N M E N T A L   E N G I N E E R I N G

INORGANIC ANALYSIS DATA SHEET

CLIENT: Stone & Webster

CLIENT SAMPLE ID NO.: N-7

E3I SAMPLE ID NO.: 88008717

Date Received: 05/10/88
Date Prepared: 05/20/88

Matrix: SOIL
% Solids: 70.0

Elements Identified and Measured

Concentrations in mg/kg dry weight

Arsenic	11
Cadmium	<0.8
Chromium	47
Copper	38
Lead	19
Mercury	<0.09
Nickel	19
Vanadium	47
Zinc	87

Comments:
"<" means that the element was not detected and that its concentration is less than the indicated value. A value in brackets indicates a concentration within five times the detection limit and therefore of lower precision.

Lab Manager: ____________

E N E R G Y   A N D   E N V I R O N M E N T A L   E N G I N E E R I N G

INORGANIC ANALYSIS DATA SHEET

CLIENT: Stone & Webster

CLIENT SAMPLE ID NO.: N-8

E3I SAMPLE ID NO.: 88008718

Date Received: 05/10/88
Date Prepared: 05/20/88

Matrix: SOIL
% Solids: 60.0

Elements Identified and Measured

Concentrations in mg/kg dry weight

Arsenic	12
Cadmium	<0.9
Chromium	68
Copper	41
Lead	19
Mercury	<0.1
Nickel	26
Vanadium	57
Zinc	99

Comments:
"<" means that the element was not detected and that its concentration is less than the indicated value. A value in brackets indicates a concentration within five times the detection limit and therefore of lower precision.

Lab Manager: [signature]

E N E R G Y   A N D   E N V I R O N M E N T A L   E N G I N E E R I N G

INORGANIC ANALYSIS DATA SHEET

CLIENT: Stone & Webster

CLIENT SAMPLE ID NO.: N-9

E3I SAMPLE ID NO.: 88008719

Date Received: 05/10/88
Date Prepared: 05/20/88

Matrix: SOIL
% Solids: 59.0

Elements Identified and Measured

Concentrations in mg/kg dry weight

Arsenic	10
Cadmium	<0.8
Chromium	75
Copper	54
Lead	53
Mercury	<0.2
Nickel	28
Vanadium	55
Zinc	130

Comments:
"<" means that the element was not detected and that its concentration is less than the indicated value. A value in brackets indicates a concentration within five times the detection limit and therefore of lower precision.

Lab Manager: Charles Miller

E N E R G Y   A N D   E N V I R O N M E N T A L   E N G I N E E R I N G

INORGANIC ANALYSIS DATA SHEET

CLIENT SAMPLE ID NO.:

CLIENT: Stone & Webster

N-10

E3I SAMPLE ID NO.: 88008720

Date Received: 05/10/88
Date Prepared: 05/20/88

Matrix: SOIL
% Solids: 65.5

Elements Identified and Measured

Concentrations in mg/kg dry weight

Arsenic	9.6
Cadmium	<0.8
Chromium	60
Copper	45
Lead	44
Mercury	<0.1
Nickel	25
Vanadium	57
Zinc	112

Comments:
"<" means that the element was not detected and that its concentration is less than the indicated value. A value in brackets indicates a concentration within five times the detection limit and therefore of lower precision.

Lab Manager:

IV. QUALITY CONTROL

Quality control for metals analyses included the additional analysis of reagent blanks and quality control samples. The reagent blank was prepared at the same time as the sample, from the same reagents. There was a small amount of chromium observed in the reagent blank; samples concentrations were corrected for this. Quality control samples were also run at the same time as were the analytical samples. These were digested at the same time and in the same manner as were the analytical samples. In this case, the Q. C. samples used were EPA Three Kid Mine (TKM85) for ICP analyses and EPA solid LCS (0287) for graphite furnace and mercury analyses. These samples are both mine tailings. Results for all elements sought fell within the limits set by the EPA for these samples. Also, at the time of sample digestion, two duplicate samples and two matrix spikes were generated and then analyzed. Nickel and zinc values did not meet established criteria in one of the duplicate samples; all elements fell within the limits in the other duplicate. Mercury spike recovery was high for one of the spike samples; it and all other elements gave good recoveries for the other spike. The most likely reason for the lack of agreement for these few elements is inhomogeneity in the sample.

FINAL REPORT

Stone and Webster
245 Summer Street
Boston, MA 02107

E3I Project Nos. 880087

Date: June 15, 1988

Prepared by:

Nicholas P. Corso
Nicholas P. Corso
Project Manager

Energy & Environmental Engineering, Inc.
35 Medford Street
Somerville, MA 02143

TABLE OF CONTENTS

I. INTRODUCTION

This report summarizes results of analyses performed on Boston Harbor core samples received by E3I from Stone & Webster 10 May 1988. Analytical Methods employed for these analyses are described in Section II, and the results are presented in Section III. Sections IV and V contain Quality Control and Quality Assurance Information.

II. METHOD SUMMARY

Analyte(s)	Method No.	Description
PAH	Mod. 8270[1]	Capillary GC/MS
PCBs	8080[1]	Solvent Extraction, Analysis by GC/ECD
Oil & Grease (O&G)	413.1[2]	Solvent Extraction, Gravimetric Determination
Volatile Solids (VS)	209 D[3]	Ignition @ 550 ^oC, Gavimetric Determination
Silt/Clay	------	% Passing No. 200 Sieve, Gravimetric Determination

[1]USEPA, SW-846 Test Methods for Evaluating Solid Waste, Physical/Chemical Methods

[2]USEPA, Methods for the Chemical Analysis of Water and Waste, EPA-600/4-79-020

[3]APHA, AWWA, WPCF, Standard Methods for the Examination of Water and Wastewater

III. RESULTS

Table I. summarizes the % water, % oil & grease, % volatile solids, % silt/clay and total PCBs for each core sample. For samples in which PCBs were not detected, the value is given as less than the detection limit. Table II lists the detection limit (ug/Kg) for the PCB analyses. Final analytical values for PAH analyses are given on the following pages.

TABLE I. % H_2O, % Oil and Grease, % Volatile Solids, Silt/Clay and Total PCB for Boston Harbor Core Samples

E3I ID	CLIENT ID	% H2O	% O&G	% VS	PCB	SILT/ CLAY
8008701	S-1	37.0	0.24	8.05	238.0	27.5
8008702	S-2	28.5	0.25	5.38	28.5	9.4
8008703	S-3	49.0	0.55	8.32	39.0	27.4
8008704	S-4	29.0	0.09	3.27	<20.0	9.9
8008705	S-5	38.0	0.24	4.96	41.3	17.2
8008706	S-6	26.0	0.05	2.18	<20.0	12.4
8008707	S-7	35.0	0.26	4.81	<20.0	21.0
8008708	S-8	38.0	0.30	8.04	<20.0	29.1
8008709	S-9	32.0	0.20	3.36	<20.0	32.1
8008710	S-10	32.0	0.07	4.05	<20.0	38.8
8008711	N-1	50.0	0.53	8.64	322.0	30.4
8008712	N-2	28.0	0.10	2.94	80.3	16.2
8008713	N-3	43.0	0.13	6.86	47.6	43.2
8008714	N-4	38.0	0.08	4.25	24.0	29.9
8008715	N-5	35.0	0.09	3.82	<20.0	37.6
8008716	N-6	38.0	0.10	3.79	32.5	14.8
8008717	N-7	30.0	0.11	4.45	<20.0	25.4
8008718	N-8	40.0	0.15	4.92	78.0	27.9
8008719	N-9	41.0	0.22	5.66	25.0	13.6
8008720	N-10	34.5	0.17	4.84	36.1	12.6
80087BLK1	----	----	0.00	0.00	<20.0	----
80087BLK2	----	----	0.00	0.00	<20.0	----
80087BLK3	----	----	----	0.00	<20.0	----
8008707DUP	----	----	0.17	----	----	----
8008710DUP	----	----	0.06	----	----	----

O&G = Oil and Grease
VS = Volatile Solids
PCB = Total PCB as Aroclor 1254; ug/Kg
SILT/CLAY = % of sample passing through No. 200 sieve (0.075mm opening)

TABLE II. Detection Limits for PCB Analyses

PCB	Detection Limit (ug/Kg)
Aroclor-1221	40.
Aroclor-1232	20.
Aroclor-1242	20.
Aroclor-1248	20.
Aroclor-1254	20.
Aroclor-1260	20.

SEMIVOLATILE ORGANICS DATA SHEET
Method 8270

Client:	STONE&WEB	Date Received:	05/10/88
Client ID:	S1	Date Extracted:	05/19/88
Lab ID:	880087-1	Date Analyzed:	05/24/88
Sample vol:	29.8 g	Dilution Factor:	1
Final vol.:	0.5 mL		
% DRY WT:	63.0		

CAS No.	COMPOUND	Concentration Units (ug/L or ug/Kg)	Q
91-20-3	Naphthalene	100	J
91-57-6	2-Methylnaphthalene	76	J
208-96-8	Acenaphthylene	19	J
83-32-9	Acenaphthene	65	J
132-64-9	Dibenzofuran	54	J
86-73-7	Fluorene	84	J
85-01-8	Phenanthrene	620	
120-12-7	Anthracene	190	
206-44-0	Fluoranthene	960	
129-00-0	Pyrene	1000	
56-55-3	Benzo(a)anthracene	450	
218-01-9	Chrysene	500	
205-99-2	Benzo(b)fluoranthene	830	
207-08-9	Benzo(k)fluoranthene	830	
50-32-8	Benzo(a)pyrene	450	
193-39-5	Indeno(1,2,3-cd)pyrene	240	J
53-70-3	Dibenz(a,h)anthracene	270	U
191-24-2	Benzo(g,h,i)perylene	240	J

(Q): Qualifiers:

U: Analyzed for but not detected
B: Found in associated sample as well as blank
J: Estimated value, less than quantitation limit
E: Estimated value, over calibration limit

SEMIVOLATILE ORGANICS DATA SHEET
Method 8270

Client:	STONE&WEB	Date Received:	05/10/88
Client ID:	S2	Date Extracted:	05/19/88
Lab ID:	880087-2	Date Analyzed:	05/24/88
Sample vol:	34.1 g	Dilution Factor:	1
Final vol.:	0.5 mL		
% DRY WT:	71.5		

CAS No.	COMPOUND	Concentration Units (ug/L or ug/Kg)	Q
91-20-3	Naphthalene	61	J
91-57-6	2-Methylnaphthalene	25	J
208-96-8	Acenaphthylene	210	U
83-32-9	Acenaphthene	32	J
132-64-9	Dibenzofuran	27	J
86-73-7	Fluorene	40	J
85-01-8	Phenanthrene	240	
120-12-7	Anthracene	95	J
206-44-0	Fluoranthene	570	
129-00-0	Pyrene	530	
56-55-3	Benzo(a)anthracene	280	
218-01-9	Chrysene	320	
205-99-2	Benzo(b)fluoranthene	560	
207-08-9	Benzo(k)fluoranthene	560	
50-32-8	Benzo(a)pyrene	320	
193-39-5	Indeno(1,2,3-cd)pyrene	200	J
53-70-3	Dibenz(a,h)anthracene	210	U
191-24-2	Benzo(g,h,i)perylene	190	J

(Q): Qualifiers:
- U: Analyzed for but not detected
- B: Found in associated sample as well as blank
- J: Estimated value, less than quantitation limit
- E: Estimated value, over calibration limit

SEMIVOLATILE ORGANICS DATA SHEET
Method 8270

Client:	STONE&WEB	Date Received:	05/10/88
Client ID:	S3	Date Extracted:	05/18/88
Lab ID:	880087-3	Date Analyzed:	05/24/88
Sample vol:	30.4 g	Dilution Factor:	1
Final vol.:	0.5 mL		
% DRY WT:	51.0		

CAS No.	COMPOUND	Concentration Units (ug/L or ug/Kg)	Q
91-20-3	Naphthalene	130	J
91-57-6	2-Methylnaphthalene	38	J
208-96-8	Acenaphthylene	320	U
83-32-9	Acenaphthene	54	J
132-64-9	Dibenzofuran	32	J
86-73-7	Fluorene	67	J
85-01-8	Phenanthrene	330	
120-12-7	Anthracene	130	J
206-44-0	Fluoranthene	770	
129-00-0	Pyrene	760	
56-55-3	Benzo(a)anthracene	400	
218-01-9	Chrysene	420	
205-99-2	Benzo(b)fluoranthene	690	
207-08-9	Benzo(k)fluoranthene	690	
50-32-8	Benzo(a)pyrene	420	
193-39-5	Indeno(1,2,3-cd)pyrene	250	J
53-70-3	Dibenz(a,h)anthracene	320	U
191-24-2	Benzo(g,h,i)perylene	250	J

(Q): Qualifiers:
- U: Analyzed for but not detected
- B: Found in associated sample as well as blank
- J: Estimated value, less than quantitation limit
- E: Estimated value, over calibration limit

SEMIVOLATILE ORGANICS DATA SHEET
Method 8270

Client:	STONE&WEB	Date Received:	05/10/88
Client ID:	S4	Date Extracted:	05/18/88
Lab ID:	880087-4	Date Analyzed:	05/24/88
Sample vol:	34.3 g	Dilution Factor:	1
Final vol.:	0.5 mL		
% DRY WT:	71.0		

CAS No.	COMPOUND	Concentration Units (ug/L or ug/Kg)	Q
91-20-3	Naphthalene	210	U
91-57-6	2-Methylnaphthalene	210	U
208-96-8	Acenaphthylene	210	U
83-32-9	Acenaphthene	210	U
132-64-9	Dibenzofuran	210	U
86-73-7	Fluorene	210	U
85-01-8	Phenanthrene	48	J
120-12-7	Anthracene	210	U
206-44-0	Fluoranthene	61	J
129-00-0	Pyrene	210	U
56-55-3	Benzo(a)anthracene	210	U
218-01-9	Chrysene	210	U
205-99-2	Benzo(b)fluoranthene	210	U
207-08-9	Benzo(k)fluoranthene	210	U
50-32-8	Benzo(a)pyrene	210	U
193-39-5	Indeno(1,2,3-cd)pyrene	210	U
53-70-3	Dibenz(a,h)anthracene	210	U
191-24-2	Benzo(g,h,i)perylene	210	U

(Q): Qualifiers:
- U: Analyzed for but not detected
- B: Found in associated sample as well as blank
- J: Estimated value, less than quantitation limit
- E: Estimated value, over calibration limit

SEMIVOLATILE ORGANICS DATA SHEET
Method 8270

Client:	STONE&WEB	Date Received:	05/10/88
Client ID:	S5	Date Extracted:	05/20/88
Lab ID:	880087-5	Date Analyzed:	05/25/88
Sample vol:	28.9 g	Dilution Factor:	1
Final vol.:	0.5 mL		
% DRY WT:	62.0		

CAS No.	COMPOUND	Concentration Units (ug/L or ug/Kg)	Q
91-20-3	Naphthalene	280	U
91-57-6	2-Methylnaphthalene	280	U
208-96-8	Acenaphthylene	280	U
83-32-9	Acenaphthene	280	U
132-64-9	Dibenzofuran	280	U
86-73-7	Fluorene	280	U
85-01-8	Phenanthrene	120	J
120-12-7	Anthracene	280	U
206-44-0	Fluoranthene	210	J
129-00-0	Pyrene	252	J
56-55-3	Benzo(a)anthracene	140	J
218-01-9	Chrysene	120	J
205-99-2	Benzo(b)fluoranthene	280	J
207-08-9	Benzo(k)fluoranthene	280	J
50-32-8	Benzo(a)pyrene	160	J
193-39-5	Indeno(1,2,3-cd)pyrene	280	U
53-70-3	Dibenz(a,h)anthracene	280	U
191-24-2	Benzo(g,h,i)perylene	280	U

(Q): Qualifiers:
- U: Analyzed for but not detected
- B: Found in associated sample as well as blank
- J: Estimated value, less than quantitation limit
- E: Estimated value, over calibration limit

SEMIVOLATILE ORGANICS DATA SHEET
Method 8270

Client:	STONE&WEB	Date Received:	05/10/88
Client ID:	S6	Date Extracted:	05/19/88
Lab ID:	880087-6	Date Analyzed:	05/25/88
Sample vol:	32.7 g	Dilution Factor:	1
Final vol.:	0.5 mL		
% DRY WT:	74.0		

CAS No.	COMPOUND	Concentration Units (ug/L or ug/Kg)	Q
91-20-3	Naphthalene	210	U
91-57-6	2-Methylnaphthalene	210	U
208-96-8	Acenaphthylene	210	U
83-32-9	Acenaphthene	210	U
132-64-9	Dibenzofuran	210	U
86-73-7	Fluorene	210	U
85-01-8	Phenanthrene	210	U
120-12-7	Anthracene	210	U
206-44-0	Fluoranthene	210	U
129-00-0	Pyrene	210	U
56-55-3	Benzo(a)anthracene	210	U
218-01-9	Chrysene	210	U
205-99-2	Benzo(b)fluoranthene	210	U
207-08-9	Benzo(k)fluoranthene	210	U
50-32-8	Benzo(a)pyrene	210	U
193-39-5	Indeno(1,2,3-cd)pyrene	210	U
53-70-3	Dibenz(a,h)anthracene	210	U
191-24-2	Benzo(g,h,i)perylene	210	U

(Q): Qualifiers:

U: Analyzed for but not detected
B: Found in associated sample as well as blank
J: Estimated value, less than quantitation limit
E: Estimated value, over calibration limit

SEMIVOLATILE ORGANICS DATA SHEET
Method 8270

Client:	STONE&WEB		Date Received:	05/10/88
Client ID:	S7		Date Extracted:	05/18/88
Lab ID:	880087-7		Date Analyzed:	05/25/88
Sample vol:	29.0		Dilution Factor:	1
Final vol.:	0.5 mL			
% DRY WT:	65.0			

CAS No.	COMPOUND	Concentration Units (ug/L or ug/Kg)	Q
91-20-3	Naphthalene	51	J
91-57-6	2-Methylnaphthalene	270	U
208-96-8	Acenaphthylene	270	U
83-32-9	Acenaphthene	270	U
132-64-9	Dibenzofuran	270	U
86-73-7	Fluorene	270	U
85-01-8	Phenanthrene	68	J
120-12-7	Anthracene	270	U
206-44-0	Fluoranthene	180	J
129-00-0	Pyrene	220	J
56-55-3	Benzo(a)anthracene	100	J
218-01-9	Chrysene	110	J
205-99-2	Benzo(b)fluoranthene	170	J
207-08-9	Benzo(k)fluoranthene	170	J
50-32-8	Benzo(a)pyrene	270	U
193-39-5	Indeno(1,2,3-cd)pyrene	270	U
53-70-3	Dibenz(a,h)anthracene	270	U
191-24-2	Benzo(g,h,i)perylene	270	U

(Q): Qualifiers:
- U: Analyzed for but not detected
- B: Found in associated sample as well as blank
- J: Estimated value, less than quantitation limit
- E: Estimated value, over calibration limit

SEMIVOLATILE ORGANICS DATA SHEET
Method 8270

Client: STONE&WEB Date Received: 05/10/88
Client ID: S8 Date Extracted: 05/19/88
Lab ID: 880087-8 Date Analyzed: 05/25/88

Sample vol: 29.7 g Dilution Factor: 1
Final vol.: 0.5 mL
% DRY WT: 62.0

CAS No.	COMPOUND	Concentration Units (ug/L or ug/Kg)	Q
91-20-3	Naphthalene	59	J
91-57-6	2-Methylnaphthalene	270	U
208-96-8	Acenaphthylene	270	U
83-32-9	Acenaphthene	22	J
132-64-9	Dibenzofuran	270	U
86-73-7	Fluorene	270	U
85-01-8	Phenanthrene	220	J
120-12-7	Anthracene	100	J
206-44-0	Fluoranthene	520	
129-00-0	Pyrene	520	
56-55-3	Benzo(a)anthracene	280	
218-01-9	Chrysene	280	
205-99-2	Benzo(b)fluoranthene	400	
207-08-9	Benzo(k)fluoranthene	400	
50-32-8	Benzo(a)pyrene	270	J
193-39-5	Indeno(1,2,3-cd)pyrene	130	J
53-70-3	Dibenz(a,h)anthracene	270	U
191-24-2	Benzo(g,h,i)perylene	130	J

(Q): Qualifiers:
- U: Analyzed for but not detected
- B: Found in associated sample as well as blank
- J: Estimated value, less than quantitation limit
- E: Estimated value, over calibration limit

SEMIVOLATILE ORGANICS DATA SHEET
Method 8270

Client:	STONE&WEB	Date Received:	05/10/88
Client ID:	S9	Date Extracted:	05/20/88
Lab ID:	880087-9	Date Analyzed:	05/26/88
Sample vol:	33.4	Dilution Factor:	1
Final vol.:	0.5 mL		
% DRY WT:	68.0		

CAS No.	COMPOUND	Concentration Units (ug/L or ug/Kg)	Q
91-20-3	Naphthalene	220	U
91-57-6	2-Methylnaphthalene	220	U
208-96-8	Acenaphthylene	220	U
83-32-9	Acenaphthene	220	U
132-64-9	Dibenzofuran	220	U
86-73-7	Fluorene	220	U
85-01-8	Phenanthrene	220	U
120-12-7	Anthracene	220	U
206-44-0	Fluoranthene	220	U
129-00-0	Pyrene	26	J
56-55-3	Benzo(a)anthracene	220	U
218-01-9	Chrysene	220	U
205-99-2	Benzo(b)fluoranthene	220	U
207-08-9	Benzo(k)fluoranthene	220	U
50-32-8	Benzo(a)pyrene	220	U
193-39-5	Indeno(1,2,3-cd)pyrene	220	U
53-70-3	Dibenz(a,h)anthracene	220	U
191-24-2	Benzo(g,h,i)perylene	220	U

(Q): Qualifiers:

- U: Analyzed for but not detected
- B: Found in associated sample as well as blank
- J: Estimated value, less than quantitation limit
- E: Estimated value, over calibration limit

SEMIVOLATILE ORGANICS DATA SHEET
Method 8270

Client:	STONE&WEB	Date Received:	05/10/88
Client ID:	S10	Date Extracted:	05/19/88
Lab ID:	880087-10	Date Analyzed:	05/25/88
Sample vol:	34.2 g	Dilution Factor:	1
Final vol.:	0.5 mL		
% DRY WT:	68.0		

CAS No.	COMPOUND	Concentration Units (ug/L or ug/Kg)	Q
91-20-3	Naphthalene	220	U
91-57-6	2-Methylnaphthalene	220	U
208-96-8	Acenaphthylene	220	U
83-32-9	Acenaphthene	220	U
132-64-9	Dibenzofuran	220	U
86-73-7	Fluorene	220	U
85-01-8	Phenanthrene	220	U
120-12-7	Anthracene	220	U
206-44-0	Fluoranthene	220	U
129-00-0	Pyrene	220	U
56-55-3	Benzo(a)anthracene	220	U
218-01-9	Chrysene	220	U
205-99-2	Benzo(b)fluoranthene	220	U
207-08-9	Benzo(k)fluoranthene	220	U
50-32-8	Benzo(a)pyrene	220	U
193-39-5	Indeno(1,2,3-cd)pyrene	220	U
53-70-3	Dibenz(a,h)anthracene	220	U
191-24-2	Benzo(g,h,i)perylene	220	U

(Q): Qualifiers:
- U: Analyzed for but not detected
- B: Found in associated sample as well as blank
- J: Estimated value, less than quantitation limit
- E: Estimated value, over calibration limit

SEMIVOLATILE ORGANICS DATA SHEET
Method 8270

Client:	STONE&WEB	Date Received:	05/10/88
Client ID:	S10	Date Extracted:	05/19/88
Lab ID:	880087-10	Date Analyzed:	05/25/88
Sample vol:	34.2 g	Dilution Factor:	1
Final vol.:	0.5 mL		
% DRY WT:	68.0		

CAS No.	COMPOUND	Concentration Units (ug/L or ug/Kg)	Q
91-20-3	Naphthalene	220	U
91-57-6	2-Methylnaphthalene	220	U
208-96-8	Acenaphthylene	220	U
83-32-9	Acenaphthene	220	U
132-64-9	Dibenzofuran	220	U
86-73-7	Fluorene	220	U
85-01-8	Phenanthrene	220	U
120-12-7	Anthracene	220	U
206-44-0	Fluoranthene	220	U
129-00-0	Pyrene	220	U
56-55-3	Benzo(a)anthracene	220	U
218-01-9	Chrysene	220	U
205-99-2	Benzo(b)fluoranthene	220	U
207-08-9	Benzo(k)fluoranthene	220	U
50-32-8	Benzo(a)pyrene	220	U
193-39-5	Indeno(1,2,3-cd)pyrene	220	U
53-70-3	Dibenz(a,h)anthracene	220	U
191-24-2	Benzo(g,h,i)perylene	220	U

(Q): Qualifiers:

U: Analyzed for but not detected
B: Found in associated sample as well as blank
J: Estimated value, less than quantitation limit
E: Estimated value, over calibration limit

SEMIVOLATILE ORGANICS DATA SHEET
Method 8270

Client:	STONE&WEB	Date Received:	05/10/88
Client ID:	N1	Date Extracted:	05/18/88
Lab ID:	880087-11	Date Analyzed:	05/25/88
Sample vol:	29.7 g	Dilution Factor:	1
Final vol.:	0.5 mL		
% DRY WT:	50.0		

CAS No.	COMPOUND	Concentration Units (ug/L or ug/Kg)	Q
91-20-3	Naphthalene	58	J
91-57-6	2-Methylnaphthalene	340	U
208-96-8	Acenaphthylene	340	U
83-32-9	Acenaphthene	340	U
132-64-9	Dibenzofuran	340	U
86-73-7	Fluorene	340	U
85-01-8	Phenanthrene	170	J
120-12-7	Anthracene	96	J
206-44-0	Fluoranthene	460	
129-00-0	Pyrene	430	
56-55-3	Benzo(a)anthracene	230	J
218-01-9	Chrysene	270	J
205-99-2	Benzo(b)fluoranthene	380	
207-08-9	Benzo(k)fluoranthene	380	
50-32-8	Benzo(a)pyrene	250	J
193-39-5	Indeno(1,2,3-cd)pyrene	120	J
53-70-3	Dibenz(a,h)anthracene	340	U
191-24-2	Benzo(g,h,i)perylene	130	J

(Q): Qualifiers:
- U: Analyzed for but not detected
- B: Found in associated sample as well as blank
- J: Estimated value, less than quantitation limit
- E: Estimated value, over calibration limit

SEMIVOLATILE ORGANICS DATA SHEET
Method 8270

Client:	STONE&WEB	Date Received:	05/10/88
Client ID:	N2	Date Extracted:	05/18/88
Lab ID:	880087-12	Date Analyzed:	05/25/88
Sample vol:	30.4 g	Dilution Factor:	1
Final vol.:	0.5 mL		
% DRY WT:	72.0		

CAS No.	COMPOUND	Concentration Units (ug/L or ug/kg)	Q
91-20-3	Naphthalene	230	U
91-57-6	2-Methylnaphthalene	230	U
208-96-8	Acenaphthylene	230	U
83-32-9	Acenaphthene	230	U
132-64-9	Dibenzofuran	230	U
86-73-7	Fluorene	230	U
85-01-8	Phenanthrene	85	J
120-12-7	Anthracene	32	J
206-44-0	Fluoranthene	120	J
129-00-0	Pyrene	210	J
56-55-3	Benzo(a)anthracene	87	J
218-01-9	Chrysene	85	J
205-99-2	Benzo(b)fluoranthene	160	J
207-08-9	Benzo(k)fluoranthene	160	J
50-32-8	Benzo(a)pyrene	110	J
193-39-5	Indeno(1,2,3-cd)pyrene	230	U
53-70-3	Dibenz(a,h)anthracene	230	U
191-24-2	Benzo(g,h,i)perylene	230	U

(Q): Qualifiers:
- U: Analyzed for but not detected
- **B: Found in associated sample as well as blank**
- J: Estimated value, less than quantitation limit
- E: Estimated value, over calibration limit

SEMIVOLATILE ORGANICS DATA SHEET
Method 8270

Client:	STONE&WEB	Date Received:	05/10/88
Client ID:	N3	Date Extracted:	05/20/88
Lab ID:	880087-13	Date Analyzed:	05/25/88
Sample vol:	26.5 g	Dilution Factor:	1
Final vol.:	0.5 mL		
% DRY WT:	57.0		

CAS No.	COMPOUND	Concentration Units (ug/L or ug/Kg)	Q
91-20-3	Naphthalene	330	U
91-57-6	2-Methylnaphthalene	330	U
208-96-8	Acenaphthylene	330	U
83-32-9	Acenaphthene	330	U
132-64-9	Dibenzofuran	330	U
86-73-7	Fluorene	330	U
85-01-8	Phenanthrene	330	U
120-12-7	Anthracene	330	U
206-44-0	Fluoranthene	330	U
129-00-0	Pyrene	330	U
56-55-3	Benzo(a)anthracene	330	U
218-01-9	Chrysene	330	U
205-99-2	Benzo(b)fluoranthene	330	U
207-08-9	Benzo(k)fluoranthene	330	U
50-32-8	Benzo(a)pyrene	330	U
193-39-5	Indeno(1,2,3-cd)pyrene	330	U
53-70-3	Dibenz(a,h)anthracene	330	U
191-24-2	Benzo(g,h,i)perylene	330	U

(Q): Qualifiers:
- U: Analyzed for but not detected
- B: Found in associated sample as well as blank
- J: Estimated value, less than quantitation limit
- E: Estimated value, over calibration limit

SEMIVOLATILE ORGANICS DATA SHEET
Method 8270

Client:	STONE&WEB	Date Received:	05/10/88
Client ID:	N4	Date Extracted:	05/20/88
Lab ID:	880087-14	Date Analyzed:	05/26/88
Sample vol:	26.8	Dilution Factor:	1
Final vol.:	0.5 mL		
% DRY WT:	62.0		

CAS No.	COMPOUND	Concentration Units (ug/L or ug/Kg)	Q
91-20-3	Naphthalene	300	U
91-57-6	2-Methylnaphthalene	300	U
208-96-8	Acenaphthylene	300	U
83-32-9	Acenaphthene	300	U
132-64-9	Dibenzofuran	300	U
86-73-7	Fluorene	300	U
85-01-8	Phenanthrene	300	U
120-12-7	Anthracene	300	U
206-44-0	Fluoranthene	39	J
129-00-0	Pyrene	60	J
56-55-3	Benzo(a)anthracene	300	U
218-01-9	Chrysene	300	U
205-99-2	Benzo(b)fluoranthene	51	J
207-08-9	Benzo(k)fluoranthene	51	J
50-32-8	Benzo(a)pyrene	300	U
193-39-5	Indeno(1,2,3-cd)pyrene	300	U
53-70-3	Dibenz(a,h)anthracene	300	U
191-24-2	Benzo(g,h,i)perylene	300	U

(Q): Qualifiers:
- U: **Analyzed for but not detected**
- B: Found in associated sample as well as blank
- J: Estimated value, less than quantitation limit
- E: Estimated value, over calibration limit

SEMIVOLATILE ORGANICS DATA SHEET
Method 8270

Client:	STONE&WEB	Date Received:	05/10/88
Client ID:	N4	Date Extracted:	05/20/88
Lab ID:	880087-14	Date Analyzed:	05/26/88
Sample vol:	26.8	Dilution Factor:	1
Final vol.:	0.5 mL		
% DRY WT:	62.0		

CAS No.	COMPOUND	Concentration Units (ug/L or ug/Kg)	Q
91-20-3	Naphthalene	300	U
91-57-6	2-Methylnaphthalene	300	U
208-96-8	Acenaphthylene	300	U
83-32-9	Acenaphthene	300	U
132-64-9	Dibenzofuran	300	U
86-73-7	Fluorene	300	U
85-01-8	Phenanthrene	300	U
120-12-7	Anthracene	300	U
206-44-0	Fluoranthene	39	J
129-00-0	Pyrene	60	J
56-55-3	Benzo(a)anthracene	300	U
218-01-9	Chrysene	300	U
205-99-2	Benzo(b)fluoranthene	51	J
207-08-9	Benzo(k)fluoranthene	51	J
50-32-8	Benzo(a)pyrene	300	U
193-39-5	Indeno(1,2,3-cd)pyrene	300	U
53-70-3	Dibenz(a,h)anthracene	300	U
191-24-2	Benzo(g,h,i)perylene	300	U

(Q): Qualifiers:
- U: Analyzed for but not detected
- B: Found in associated sample as well as blank
- J: Estimated value, less than quantitation limit
- E: Estimated value, over calibration limit

SEMIVOLATILE ORGANICS DATA SHEET
Method 8270

Client:	STONE&WEB	Date Received:	05/10/88
Client ID:	N5	Date Extracted:	05/20/88
Lab ID:	880087-15	Date Analyzed:	05/25/88
Sample vol:	28.6	Dilution Factor:	1
Final vol.:	0.5 mL		
% DRY WT:	65.0		

CAS No.	COMPOUND	Concentration Units (ug/L or ug/Kg)	Q
91-20-3	Naphthalene	270	U
91-57-6	2-Methylnaphthalene	270	U
208-96-8	Acenaphthylene	270	U
83-32-9	Acenaphthene	270	U
132-64-9	Dibenzofuran	270	U
86-73-7	Fluorene	270	U
85-01-8	Phenanthrene	270	U
120-12-7	Anthracene	270	U
206-44-0	Fluoranthene	270	U
129-00-0	Pyrene	59	J
56-55-3	Benzo(a)anthracene	270	U
218-01-9	Chrysene	270	U
205-99-2	Benzo(b)fluoranthene	270	U
207-08-9	Benzo(k)fluoranthene	270	U
50-32-8	Benzo(a)pyrene	270	U
193-39-5	Indeno(1,2,3-cd)pyrene	270	U
53-70-3	Dibenz(a,h)anthracene	270	U
191-24-2	Benzo(g,h,i)perylene	270	U

(Q): Qualifiers:

U: Analyzed for but not detected
B: Found in associated sample as well as blank
J: Estimated value, less than quantitation limit
E: Estimated value, over calibration limit

SEMIVOLATILE ORGANICS DATA SHEET
Method 8270

Client:	STONE&WEB	Date Received:	05/10/88
Client ID:	N6	Date Extracted:	05/18/88
Lab ID:	88087-16	Date Analyzed:	05/26/88
Sample vol:	34.2	Dilution Factor:	1
Final vol.:	0.5 mL		
% DRY WT:	62.0		

CAS No.	COMPOUND	Concentration Units (ug/L or ug/Kg)	Q
91-20-3	Naphthalene	240	U
91-57-6	2-Methylnaphthalene	240	U
208-96-8	Acenaphthylene	240	U
83-32-9	Acenaphthene	240	U
132-64-9	Dibenzofuran	240	U
86-73-7	Fluorene	240	U
85-01-8	Phenanthrene	240	U
120-12-7	Anthracene	240	U
206-44-0	Fluoranthene	34	J
129-00-0	Pyrene	62	J
56-55-3	Benzo(a)anthracene	29	J
218-01-9	Chrysene	29	J
205-99-2	Benzo(b)fluoranthene	240	U
207-08-9	Benzo(k)fluoranthene	240	U
50-32-8	Benzo(a)pyrene	240	U
193-39-5	Indeno(1,2,3-cd)pyrene	240	U
53-70-3	Dibenz(a,h)anthracene	240	U
191-24-2	Benzo(g,h,i)perylene	240	U

(Q): Qualifiers:
- U: Analyzed for but not detected
- B: Found in associated sample as well as blank
- J: Estimated value, less than quantitation limit
- E: Estimated value, over calibration limit

SEMIVOLATILE ORGANICS DATA SHEET
Method 8270

Client:	STONE&WEB	Date Received:	05/10/88
Client ID:	N7	Date Extracted:	05/19/88
Lab ID:	880087-17	Date Analyzed:	05/25/88
Sample vol:	37.0 g	Dilution Factor:	1
Final vol.:	0.5 mL		
% DRY WT:	70.0		

CAS No.	COMPOUND	Concentration Units (ug/L or ug/Kg)	Q
91-20-3	Naphthalene	100	U
91-57-6	2-Methylnaphthalene	100	U
208-96-8	Acenaphthylene	100	U
83-32-9	Acenaphthene	100	U
132-64-9	Dibenzofuran	100	U
86-73-7	Fluorene	100	U
85-01-8	Phenanthrene	100	U
120-12-7	Anthracene	100	U
206-44-0	Fluoranthene	100	U
129-00-0	Pyrene	100	U
56-55-3	Benzo(a)anthracene	100	U
218-01-9	Chrysene	100	U
205-99-2	Benzo(b)fluoranthene	100	U
207-08-9	Benzo(k)fluoranthene	100	U
50-32-8	Benzo(a)pyrene	100	U
193-39-5	Indeno(1,2,3-cd)pyrene	100	U
53-70-3	Dibenz(a,h)anthracene	100	U
191-24-2	Benzo(g,h,i)perylene	100	U

(Q): Qualifiers:
- U: Analyzed for but not detected
- B: Found in associated sample as well as blank
- J: Estimated value, less than quantitation limit
- E: Estimated value, over calibration limit

SEMIVOLATILE ORGANICS DATA SHEET
Method 8270

Client:	STONE&WEB	Date Received:	05/10/88	
Client ID:	N8	Date Extracted:	05/19/88	
Lab ID:	880087-18	Date Analyzed:	05/25/88	
Sample vol:	17.0	Dilution Factor:	1	
Final vol.:	0.5 mL			
% DRY WT:	60.0			

CAS No.	COMPOUND	Concentration Units (ug/L or ug/Kg)	Q
91-20-3	Naphthalene	490	U
91-57-6	2-Methylnaphthalene	490	U
208-96-8	Acenaphthylene	490	U
83-32-9	Acenaphthene	490	U
132-64-9	Dibenzofuran	490	U
86-73-7	Fluorene	490	U
85-01-8	Phenanthrene	66	J
120-12-7	Anthracene	490	U
206-44-0	Fluoranthene	78	J
129-00-0	Pyrene	150	J
56-55-3	Benzo(a)anthracene	490	U
218-01-9	Chrysene	490	U
205-99-2	Benzo(b)fluoranthene	490	U
207-08-9	Benzo(k)fluoranthene	490	U
50-32-8	Benzo(a)pyrene	490	U
193-39-5	Indeno(1,2,3-cd)pyrene	490	U
53-70-3	Dibenz(a,h)anthracene	490	U
191-24-2	Benzo(g,h,i)perylene	490	U

(Q): Qualifiers:
- U: Analyzed for but not detected
- B: Found in associated sample as well as blank
- J: Estimated value, less than quantitation limit
- E: Estimated value, over calibration limit

SEMIVOLATILE ORGANICS DATA SHEET
Method 8270

Client:	STONE&WEB	Date Received:	05/10/88
Client ID:	N9	Date Extracted:	05/20/88
Lab ID:	880087-19	Date Analyzed:	05/25/88
Sample vol:	27.6	Dilution Factor:	1
Final vol.:	0.5 mL		
% DRY WT:	59.0		

CAS No.	COMPOUND	Concentration Units (ug/L or ug/Kg)	Q
91-20-3	Naphthalene	310	U
91-57-6	2-Methylnaphthalene	310	U
208-96-8	Acenaphthylene	310	U
83-32-9	Acenaphthene	310	U
132-64-9	Dibenzofuran	310	U
86-73-7	Fluorene	310	U
85-01-8	Phenanthrene	90	J
120-12-7	Anthracene	310	U
206-44-0	Fluoranthene	180	J
129-00-0	Pyrene	280	J
56-55-3	Benzo(a)anthracene	90	J
218-01-9	Chrysene	140	J
205-99-2	Benzo(b)fluoranthene	260	J
207-08-9	Benzo(k)fluoranthene	260	J
50-32-8	Benzo(a)pyrene	150	J
193-39-5	Indeno(1,2,3-cd)pyrene	81	J
53-70-3	Dibenz(a,h)anthracene	310	U
191-24-2	Benzo(g,h,i)perylene	310	U

(Q): Qualifiers:
- U: Analyzed for but not detected
- B: Found in associated sample as well as blank
- J: Estimated value, less than quantitation limit
- E: Estimated value, over calibration limit

SEMIVOLATILE ORGANICS DATA SHEET
Method 8270

Client:	STONE&WEB	Date Received:	05/10/88
Client ID:	N10	Date Extracted:	05/18/88
Lab ID:	880087-20	Date Analyzed:	05/25/88
Sample vol:	29.5	Dilution Factor:	1
Final vol.:	0.5 mL		
% DRY WT:	65.5		

CAS No.	COMPOUND	Concentration Units (ug/L or ug/Kg)	Q
91-20-3	Naphthalene	260	U
91-57-6	2-Methylnaphthalene	260	U
208-96-8	Acenaphthylene	260	U
83-32-9	Acenaphthene	260	U
132-64-9	Dibenzofuran	260	U
86-73-7	Fluorene	260	U
85-01-8	Phenanthrene	110	J
120-12-7	Anthracene	260	U
206-44-0	Fluoranthene	140	J
129-00-0	Pyrene	300	
56-55-3	Benzo(a)anthracene	99	J
218-01-9	Chrysene	110	J
205-99-2	Benzo(b)fluoranthene	190	J
207-08-9	Benzo(k)fluoranthene	190	J
50-32-8	Benzo(a)pyrene	99	J
193-39-5	Indeno(1,2,3-cd)pyrene	260	U
53-70-3	Dibenz(a,h)anthracene	260	U
191-24-2	Benzo(g,h,i)perylene	260	U

(Q): Qualifiers:
- U: Analyzed for but not detected
- B: Found in associated sample as well as blank
- J: Estimated value, less than quantitation limit
- E: Estimated value, over calibration limit

IV. QUALITY CONTROL INFORMATION

Quality Control for organic analyses included the additional analysis of reagent blanks and quality control samples. The reagent blanks were prepared at the same time as the samples, from the same reagents. Quality control samples were also run at the same time as were the analytical samples. Reagent blanks were found to be free from laboratory contamination.

Four matrix spikes were generated and analyzed during the PAH analyses. 2,4-Dinitrotoluene spike recovery was high for the four spiked samples. All other spiked compounds met established criteria. Results for the matrix spike and matrix spike duplicate analyses are summarized on the following pages.

Two matrix spikes were generated and analyzed during the PCB analyses. Aroclor 1260 spike recovery was 290% and 52% in 880087-18MS and 880087-18MSD, respectively. The RPD of 139 may be attributed to sample matrix effects.

SEMIVOLATILE ORGANICS DATA SHEET
Method 8270

Client:	STONE&WEB	Date Received:	05/10/88
Client ID:	--------	Date Extracted:	05/18/88
Lab ID:	880087-BK1	Date Analyzed:	05/24/88
Sample vol:	30.0 g	Dilution Factor:	1
Final vol.:	0.5 mL		
% DRY WT:	100.0		

CAS No.	COMPOUND	Concentration Units (ug/L or ug/Kg)	Q
91-20-3	Naphthalene	170	U
91-57-6	2-Methylnaphthalene	170	U
208-96-8	Acenaphthylene	170	U
83-32-9	Acenaphthene	170	U
132-64-9	Dibenzofuran	170	U
86-73-7	Fluorene	170	U
85-01-8	Phenanthrene	170	U
120-12-7	Anthracene	170	U
206-44-0	Fluoranthene	170	U
129-00-0	Pyrene	170	U
56-55-3	Benzo(a)anthracene	170	U
218-01-9	Chrysene	170	U
205-99-2	Benzo(b)fluoranthene	170	U
207-08-9	Benzo(k)fluoranthene	170	U
50-32-8	Benzo(a)pyrene	170	U
193-39-5	Indeno(1,2,3-cd)pyrene	170	U
53-70-3	Dibenz(a,h)anthracene	170	U
191-24-2	Benzo(g,h,i)perylene	170	U

(Q): Qualifiers:
- U: Analyzed for but not detected
- B: Found in associated sample as well as blank
- J: Estimated value, less than quantitation limit
- E: Estimated value, over calibration limit

SEMIVOLATILE ORGANICS DATA SHEET
Method 8270

Client:	STONE&WEB	Date Received:	05/10/88
Client ID:	-------	Date Extracted:	05/19/88
Lab ID:	880087-BL2	Date Analyzed:	05/24/88
Sample vol:	30.0 g	Dilution Factor:	1
Final vol.:	0.5 mL		
% DRY WT:	100.0		

CAS No.	COMPOUND	Concentration Units (ug/L or ug/Kg)	Q
91-20-3	Naphthalene	170	U
91-57-6	2-Methylnaphthalene	170	U
208-96-8	Acenaphthylene	170	U
83-32-9	Acenaphthene	170	U
132-64-9	Dibenzofuran	170	U
86-73-7	Fluorene	170	U
85-01-8	Phenanthrene	170	U
120-12-7	Anthracene	170	U
206-44-0	Fluoranthene	170	U
129-00-0	Pyrene	170	U
56-55-3	Benzo(a)anthracene	170	U
218-01-9	Chrysene	170	U
205-99-2	Benzo(b)fluoranthene	170	U
207-08-9	Benzo(k)fluoranthene	170	U
50-32-8	Benzo(a)pyrene	170	U
193-39-5	Indeno(1,2,3-cd)pyrene	170	U
53-70-3	Dibenz(a,h)anthracene	170	U
191-24-2	Benzo(g,h,i)perylene	170	U

(Q): Qualifiers:
- U: Analyzed for but not detected
- B: Found in associated sample as well as blank
- J: Estimated value, less than quantitation limit
- E: Estimated value, over calibration limit

SEMIVOLATILE ORGANICS DATA SHEET
Method 8270

Client:	STONE&WEB	Date Received:	05/10/88
Client ID:	-------	Date Extracted:	05/20/88
Lab ID:	880087-BL3	Date Analyzed:	05/24/88

Sample vol:	30.0 g	Dilution Factor:	1
Final vol.:	0.5 mL		
% DRY WT:	100.0		

CAS No.	COMPOUND	Concentration Units (ug/L or ug/Kg)	Q
91-20-3	Naphthalene	170	U
91-57-6	2-Methylnaphthalene	170	U
208-96-8	Acenaphthylene	170	U
83-32-9	Acenaphthene	170	U
132-64-9	Dibenzofuran	170	U
86-73-7	Fluorene	170	U
85-01-8	Phenanthrene	170	U
120-12-7	Anthracene	170	U
206-44-0	Fluoranthene	170	U
129-00-0	Pyrene	170	U
56-55-3	Benzo(a)anthracene	170	U
218-01-9	Chrysene	170	U
205-99-2	Benzo(b)fluoranthene	170	U
207-08-9	Benzo(k)fluoranthene	170	U
50-32-8	Benzo(a)pyrene	170	U
193-39-5	Indeno(1,2,3-cd)pyrene	170	U
53-70-3	Dibenz(a,h)anthracene	170	U
191-24-2	Benzo(g,h,i)perylene	170	U

(Q): Qualifiers:
- U: Analyzed for but not detected
- B: Found in associated sample as well as blank
- J: Estimated value, less than quantitation limit
- E: Estimated value, over calibration limit

SEMIVOLATILE ORGANICS DATA SHEET
Method 8270

Client: STONE&WEB   Date Received: 05/10/88
Client ID: S4 MS   Date Extracted: 05/18/88
Lab ID: 880087-4MS   Date Analyzed: 05/24/88

Sample vol: 16.6 g   Dilution Factor: 1
Final vol.: 0.5 mL
% DRY WT: 71.0

CAS No.	COMPOUND	Concentration Units (ug/L or ug/Kg)	Q
91-20-3	Naphthalene	55	J
91-57-6	2-Methylnaphthalene	420	U
208-96-8	Acenaphthylene	420	U
83-32-9	Acenaphthene	MS	
132-64-9	Dibenzofuran	420	U
86-73-7	Fluorene	43	J
85-01-8	Phenanthrene	280	J
120-12-7	Anthracene	150	J
206-44-0	Fluoranthene	870	
129-00-0	Pyrene	MS	
56-55-3	Benzo(a)anthracene	500	
218-01-9	Chrysene	420	J
205-99-2	Benzo(b)fluoranthene	90	J
207-08-9	Benzo(k)fluoranthene	90	J
50-32-8	Benzo(a)pyrene	420	J
193-39-5	Indeno(1,2,3-cd)pyrene	240	J
53-70-3	Dibenz(a,h)anthracene	420	U
191-24-2	Benzo(g,h,i)perylene	210	J

(Q): Qualifiers:
- U: Analyzed for but not detected
- B: Found in associated sample as well as blank
- J: Estimated value, less than quantitation limit
- E: Estimated value, over calibration limit
- MS: Matrix Spike Compound

SEMIVOLATILE ORGANICS DATA SHEET
Method 8270

Client:	STONE&WEB	Date Received:	05/10/88
Client ID:	S4 MSD	Date Extracted:	05/18/88
Lab ID:	880087-4SD	Date Analyzed:	05/24/88
Sample vol:	21.0 g	Dilution Factor:	1
Final vol.:	0.5 mL		
% DRY WT:	71.0		

CAS No.	COMPOUND	Concentration Units (ug/L or ug/Kg)	Q
91-20-3	Naphthalene	37	J
91-57-6	2-Methylnaphthalene	340	U
208-96-8	Acenaphthylene	340	U
83-32-9	Acenaphthene	MS	
132-64-9	Dibenzofuran	340	U
86-73-7	Fluorene	340	U
85-01-8	Phenanthrene	120	J
120-12-7	Anthracene	39	J
206-44-0	Fluoranthene	170	J
129-00-0	Pyrene	MS	
56-55-3	Benzo(a)anthracene	110	J
218-01-9	Chrysene	96	J
205-99-2	Benzo(b)fluoranthene	340	U
207-08-9	Benzo(k)fluoranthene	340	U
50-32-8	Benzo(a)pyrene	100	J
193-39-5	Indeno(1,2,3-cd)pyrene	340	U
53-70-3	Dibenz(a,h)anthracene	340	U
191-24-2	Benzo(g,h,i)perylene	340	U

(Q): Qualifiers:
- U: Analyzed for but not detected
- B: Found in associated sample as well as blank
- J: Estimated value, less than quantitation limit
- E: Estimated value, over calibration limit
- MS: Matrix Spike Compound

SEMIVOLATILE ORGANICS DATA SHEET
Method 8270

Client:	STONE&WEB	Date Received:	05/10/88
Client ID:	N8 MS	Date Extracted:	05/19/88
Lab ID:	880087-18S	Date Analyzed:	05/25/88

Sample vol:	16.6 g	Dilution Factor:	1
Final vol.:	0.5 mL		
% DRY WT:	60.0		

CAS No.	COMPOUND	Concentration Units (ug/L or ug/Kg)	Q
91-20-3	Naphthalene	500	U
91-57-6	2-Methylnaphthalene	500	U
208-96-8	Acenaphthylene	500	U
83-32-9	Acenaphthene	MS	
132-64-9	Dibenzofuran	500	U
86-73-7	Fluorene	500	U
85-01-8	Phenanthrene	110	J
120-12-7	Anthracene	500	U
206-44-0	Fluoranthene	240	J
129-00-0	Pyrene	MS	
56-55-3	Benzo(a)anthracene	98	J
218-01-9	Chrysene	120	J
205-99-2	Benzo(b)fluoranthene	79	J
207-08-9	Benzo(k)fluoranthene	79	J
50-32-8	Benzo(a)pyrene	100	J
193-39-5	Indeno(1,2,3-cd)pyrene	500	U
53-70-3	Dibenz(a,h)anthracene	500	U
191-24-2	Benzo(g,h,i)perylene	500	U

(Q): Qualifiers:
- U: Analyzed for but not detected
- B: Found in associated sample as well as blank
- J: Estimated value, less than quantitation limit
- E: Estimated value, over calibration limit
- MS: Matrix Spike Compound

SEMIVOLATILE ORGANICS DATA SHEET
Method 8270

Client:	STONE&WEB	Date Received:	05/10/88
Client ID:	N8 MSD	Date Extracted:	05/19/88
Lab ID:	880087-18D	Date Analyzed:	05/25/88
Sample vol:	21.6 g	Dilution Factor:	1
Final vol.:	0.5 mL		
% DRY WT:	60.0		

CAS No.	COMPOUND	Concentration Units (ug/L or ug/Kg)	Q
91-20-3	Naphthalene	390	U
91-57-6	2-Methylnaphthalene	390	U
208-96-8	Acenaphthylene	390	U
83-32-9	Acenaphthene	MS	
132-64-9	Dibenzofuran	390	U
86-73-7	Fluorene	390	U
85-01-8	Phenanthrene	70	J
120-12-7	Anthracene	390	U
206-44-0	Fluoranthene	120	J
129-00-0	Pyrene	MS	
56-55-3	Benzo(a)anthracene	71	J
218-01-9	Chrysene	69	J
205-99-2	Benzo(b)fluoranthene	100	J
207-08-9	Benzo(k)fluoranthene	100	J
50-32-8	Benzo(a)pyrene	390	U
193-39-5	Indeno(1,2,3-cd)pyrene	390	U
53-70-3	Dibenz(a,h)anthracene	390	U
191-24-2	Benzo(g,h,i)perylene	390	U

(Q): Qualifiers:
- U: Analyzed for but not detected
- B: Found in associated sample as well as blank
- J: Estimated value, less than quantitation limit
- E: Estimated value, over calibration limit
- MS: Matrix Spike Compound

SOIL MATRIX SPIKE / MATRIX SPIKE DUPLICATE RECOVERY

E3I Project Number: 880087 Lab ID: 880087-18MS

Client: STONE & WEBSTER Client ID: N8-MS

COMPOUND	SPIKE ADDED (ug/Kg)	SAMPLE CONC (ug/Kg)	MS CONC (ug/Kg)	MS % REC	MSD CONC (ug/Kg)	MSD % REC	RPD	QC RPD	LIMITS RECOVERY
1,2,4-Trichlorobenzene	5000/3900	Ø	3613	72	2490	64	12	23	38-107
Acenaphthene	5000/3900	Ø	4265	85	2778	71	18	19	31-137
2,4-Dinitrotoluene	5000/3900	Ø	6151	123 *	3543	91 *	30	47	28-89
Pyrene	5000/3900	146	4355	84	2811	68	21	36	35-142
N-Nitrosodi-n-Propylamine	5000/3900	Ø	4139	83	2592	66	23	38	41-126
1,4-Dichlorobenzene	5000/3900	Ø	3185	64	2120	54	17	27	28-104

* Values outside QC limits

RPD: 0 out of 6 outside limits

Spike Recovery: 2 out of 12 outside limits

SOIL MATRIX SPIKE / MATRIX SPIKE DUPLICATE RECOVERY

E3I Project Number: 880087 Lab ID: 880087-4 MS

Client: STONE + WEBSTER Client ID: S4-MS

COMPOUND	SPIKE ADDED (ug/Kg)	SAMPLE CONC (ug/Kg)	MS CONC (ug/Kg)	MS % REC	MSD CONC (ug/Kg)	MSD % REC	RPD	QC RPD	LIMITS RECOVERY
1,2,4-Trichlorobenzene	4200/3400	Ø	4243	101	3172	93	8	23	38-107
Acenaphthene	4200/3400	Ø	3566	85	2625	77	10	19	31-137
2,4-Dinitrotoluene	4200/3400	Ø	4505	107 *	3118	92 *	15	47	28-89
Pyrene	4200/3400	Ø	3319	79	2437	72	9	36	35-142
N-Nitrosodi-n-Propylamine	4200/3400	Ø	3414	81	2525	74	9	38	41-126
1,4-Dichlorobenzene	4200/3400	Ø	2959	70	2211	65	7	27	28-104

* Values outside QC limits

RPD: 0 out of 6 outside limits

Spike Recovery: 2 out of 12 outside limits

V. DATA RELEASE AUTHORIZATION

This data has been reviewed and is hereby authorized for release by:

Philip J. Doherty
Vice President

SECONDARY TREATMENT FACILITIES PLAN
SUPPLEMENT TO APPENDIX H, VOLUME III

APPENDIX C

MARINE ARCHAEOLOGY

MARINE ARCHAEOLOGICAL PHASE 1 EVALUATION

for the

DEER ISLAND FIXED CABLE CROSSING, INNER BOSTON HARBOR
MASSACHUSETTS WATER RESOURCES AUTHORITY
SECONDARY TREATMENT FACILITIES PLAN

Submitted by:

,Paul Forsythe Johnston, Ph.D.
150 Beach Bluff Avenue
Swampscott, MA 01907

under subcontract to:

Camp Dresser & Mckee Inc.
One Center Plaza
Boston, MA 02108

for:

Stone & Webster Engineering Corporation
245 Summer Street
Boston, MA 02107

TABLE OF CONTENTS

LIST OF FIGURES

MARINE ARCHAEOLOGICAL PHASE 1 EVALUATION

1. Abstract

In accordance with Section 106 Review Procedures of the Massachusetts Historical Commission regarding the Deer Island Fixed Cable Crossing in inner Boston Harbor, this report summarizes the governing legislation and documentary evidence for historic/archaeological shipwreck sites within the vicinity of the proposed cable pathway(s). Also discussed are past harbor construction projects with potential impact upon historic wrecksites, the effects of harbor bottom characteristics upon shipwreck preservation, the impact of cable laying and associated construction upon wrecksites that may lie within the cable pathway(s) and recommendations for additional research and survey.

2. Governing Legislation

Section 106 of the National Historic Preservation Act (NHPA) of 1966 (36 CFR 800, revised 2 September 1986 in 51 FR 31115) requires an evaluation of federal projects' impact(s) upon historic properties listed in or eligible for the National Register of Historic Places. In the context of this report, historic properties may be defined as sites or archaeological resources of local, state or national significance that may be associated with important historical people or events in history, architecture,

archaeology or technology or that may have historical research value. The minimum age criterion for a qualifying property is fifty (50) years, if it is of exceptional importance.[1] Insofar as historic watercraft or shipwrecks are concerned, further definitions exist, defining them as "any craft built to navigate a waterway....which meets the National Register criteria for evaluation....retain[ing] integrity of location, design, setting, materials, workmanship, feeling, and association."[2]

On 28 April 1988, the President of the United States signed into law the Abandoned Shipwreck Act (S. 858). In essence, this legislation turns over jurisdiction of submerged cultural resources within state waters to the states themselves. The National Park Service (NPS) has been mandated to formulate guidelines for the administration and implementation of this law. It is expected that NPS guidelines will follow National Register criteria; however, it is currently unclear how this legislation will interface with the NHPA of 1966 regarding submerged cultural properties within state waters.

Under the Massachusetts Underwater Archaeology Act of 1973, shipwrecks and artifacts from the Commonwealth's coastal waters that are more than one hundred (100) years old or that are worth more than five thousand dollars ($5,000), as well as any objects considered to be of historic interest by the Massachusetts Board of Underwater Archaeological Resources, are of potential historic and/or archaeological value and are

---

1 See 36 CFR 60.6(g).

2 See Delgado et al., 1987:2-3.

protected by legislation.[3] For the following report, the more conservative NHPA standards have been observed.

3. Documentary Sources for Historic/Archaeological Shipwreck Sites in Inner Boston Harbor

Utilizing the NHPA criteria as guidelines, more than three dozen published and unpublished sources were consulted in the documentation of historic wrecksites in inner Boston Harbor (Figure 1).[4] Ranging in date from 1840 to 1988, these documents include manuscripts, scholarly and popular articles, brochures, reports and books on the region's shipwrecks, storms, sportdiving, the port of Boston and the harbor islands. Various government publications also were consulted, including the weekly **Notice to Mariners** and the annual reports and special publications of the U.S. Coast Guard, the Massachusetts Humane Society, the U.S. Lifesaving Service and the Army Corps of Engineers, New England District.

With variable degrees of historical and geographical accuracy, these sources document shipwrecks in Boston Harbor from as early as 1645 to as recent as 1986. In general, the earlier documents, particularly those works written for a lay or popular audience, are less accurate, especially in regard to the specific locations of wrecksites. By contrast, the more recent

[3] See Massachusetts General Laws, Chapter 6, Sections 179 and 180, Chapter 9, Section 26, Chapter 12, Section 11D; Chapter 30, Section 61 and Chapter 91, Sections 63 and 72. See also Code of Massachusetts Regulations (CMR) 312, 2.00-2.17.

[4] As shown by Figure 1, the region under investigation for this report is bounded on the east by Deer Island, on the South by Castle Island and the Reserved Channel, and on the north by Logan International Airport and Orient Heights Beach.

government publications and the particularistic shipwreck books and articles can offer far greater accuracy, up to and including longitudinal and latitudinal chart coordinates (see Bibliographical Sources).

For construction projects that might affect the presence and/or preservation of historic shipwreck sites in inner Boston Harbor, reports and records maintained at the New England Division of the U.S. Army Corps of Engineers at Waltham, MA were consulted. These resources, located severally at the Division of Planning and Research, the Bureau of Navigation and the associated library and archives, are comprised of draft reports, published documents, maps and charts relating to Corps activities and construction projects in Boston Harbor from 1825 to 1988 (see Bibliographical Sources).[5]

4. <u>Documented and Undocumented Wrecksites, Inner Boston Harbor</u>

Boston's inner harbor shoreline, from Grovers Cliff at Winthrop Highlands to the southern tip of Deer Island, contains one of the three highest concentrations of historic shipwreck sites in all of Massachusetts Bay.[6] Approximately three miles in length, this section of coast incorporates 17 documented historic shipwreck sites ranging in date from an unidentified sloop that wrecked at Winthrop in 1682 to the 23-foot motor yacht **Moxie**,

[5] The assistance of Marie Bourassa, Staff Archaeologist for the Division of Planning and Carl Boutilier, Chief of the Bureau of Navigation, is gratefully acknowledged in the preparation of this report.

[6] The other two regions are the Hull/Nantasket shoreline and the outer harbor islands, both of which lie outside the purview of this report.

lost at Winthrop in 1917.[7] The principal reasons for this high incidence of wreckings are the high volume of traffic along this beachline and the prevailing northeasterly storms and storm winds, which combined to drive vessels moving, moored or anchored in the outer harbor against the shore.[8] All of these wreckings occurred on the eastern (outer) side of this shore, itself outside the scope of this report. However, it is possible that some of these wrecks or their parts may have been forced into the inner harbor either through Shirley Gut or from around the southern end of Deer Island. Shirley Gut, a section of open water between Point Shirley and Deer Island linking the inner and outer harbors, existed from the earliest settlement of Boston to as late as 1935 (Figure 2).[9] Because of the variable shape and depth of this topographical feature prior to its closure, it is not possible to predict the potential likelihood or frequency of occurrence of this hypothesis.

In 1980, the Army Corps of Engineers published the results of an extensive debris source inventory which cataloged all of the visible structures, including shipwreck sites, around Boston Harbor and the harbor islands.[10] Studying the feasibility of removing various types of debris in

[7] See Snow, 1943:85-351, 1960:235-50; Berman, 1972: numbers 1886 and 3058, Smith, 1917:18-65; Dugan and Bradbury, n.d.:2-6.

[8] See Smith, 1917:passim, especially p. 64. Snow, 1943:97 states that 60 vessels were wrecked, stranded, damaged or foundered in the Gale of September 1815 in Boston harbor. W.P.A., 1941:103 states that the Great Hurricane of December 1839 caused more than 20 wrecks in Boston harbor; Smith, 1917:22 attributes more than 90 losses and approximately 200 dismastings, groundings or damaged vessels to the 1839 storm.

[9] Army Corps of Engineers, 1988:1-42. After 1940, a causeway was built over the filled-in gut, joining Winthrop and Deer Island.

order to improve harbor navigation and development possibilities, this shoreline survey did not locate any wrecksites within the area potentially impacted by the inner harbor fixed cable crossing.[11] Nor are any wrecksites recorded along the proposed cable pathway(s) upon the most recent navigational charts available to the public.[12] Furthermore, this present study has not located any shipwreck sites of potential historic or archaeological significance within the potentially impacted area(s).

However, this should not necessarily suggest that such sites are not present, only that they are undocumented in the available literature. Among the categories of unrecorded sites that might exist in inner Boston Harbor are ships which may have sunk during storms or other conditions of low visibility (such as fog), vessels (especially small craft) that sank at anchor and might not have warranted salvage, and vessels engaged in illicit or illegal activity unreported to the authorities. Even if such sites do exist, however, it is unlikely that they are sufficently preserved to warrant extensive scientific investigation or excavation. Widespread construction and dredging throughout inner Boston Harbor, both by the Army Corps of Engineers and for Logan International Airport, would threaten the preservation of any sites of potential historic or archaeological significance. In addition, vessels raising, lowering and dragging anchors or

[10] Army Corps of Engineers, 1980: 2 vols.

[11] Ibid. Appendix 4, figures A-76 through A-82 inclusive.

[12] I.e., N.O.A.A./N.O.S. Chart No. 13270 for Boston harbor, 49th Ed., 19 April 1986, and No. 13272 for Boston Inner Harbor, 38th Ed., 20 March 1982. However, government navigation charts seldom record historic wrecksites unless they are navigating hazards, in which case they are usually salvaged or demolished.

moorings of all sizes throughout this region over the past 350 years would also damage or destroy such sites, as would shellfish dredging or trapping.[13]

Dredging operations for the maintenance of deepwater navigating channels in inner Boston Harbor by the Army Corps of Engineers are of particular relevance to this report. In 1881, the Corps began removing sand bars, ledges, rocks and boulders in the Main Harbor Channel to the south; by 1888 it was 23 feet deep at mean low water (MLW) and from 600 to 1,100 feet wide at the upper middle section (see Figure 3).[14] By 1911, the Main Channel was dredged to a depth of 27 feet MLW (see Figure 4); subsequent dredging and navigational maintenance projects increased the figure to a depth of 35 (inbound) to 40 (outbound) feet MLW and a width of 1,200 feet. Similarly, the Reserved Channel was incrementally dredged to its current depth of 35 feet MLW; proposals for dredging it to 38-40 feet MLW are pending (see Figure 5).[15]

On the northern end of the inner harbor, there has been little construction beyond the filling and levelling for East Boston and Logan Airport in the late 1930s that would have had significant impact upon

[13] Figure 2, the 1875 Army Corps of Engineers map of harbor improvements, records the presence of extensive oyster beds between Chelsea Point and East Boston. Today, shellfishing is restricted in the inner and much of the outer harbor. See Army Corps of Engineers, 1988:13, fig.4.

[14] See Army Corps of Engineers, vol. 1, 1881:102 through 1888:189 inclusive.

[15] See Army Corps of Engineers, 1988:44

submerged historic sites.[16] East Boston originally maintained an active waterfront; after the airport fill, however, the northern channel to Winthrop and Orient Heights became so constricted that commercial shipping activity declined to insignificant proportions in this region of the harbor.

In summary, there is no documentary evidence for the presence of historic shipwreck sites in the vicinity of the proposed pathway for the fixed cable crossing between Deer Island and the city of Boston at the southern or northern terminals of the cable. The extensive dredging and construction within the harbor from the late nineteenth century to the present would further suggest that if such wrecksites were found, their condition would be unlikely to warrant extensive scientific inquiry.

5. The Effects of Harbor Bottom Type and Conditions on Shipwreck Preservation

For this section of the report, current navigational charts and an environmental report prepared by the Army Corps of Engineers assessing the impact of proposed inner harbor dredging were reviewed.[17]

---

[16] Ibid: 1-38 to 1-40.

[17] William A. Hubbard, "A Draft Environmental Assessment of the Proposed Boston Harbor Improvement Dredging Project in Boston, Massachusetts," in Army Corps of Engineers, 1988. Appendix EA. This report, which sampled various sites' sea bottom characteristics in the Reserved and Main Harbor Channels to a maximum depth of 1.5 meters, concluded that dredging these channels would have no significant impact upon submerged historic/archaeological resources on account of past navigational improvement projects. See especially pp. 1-2 and EA-37 of this appendix.

Among the many environmental factors influencing the preservation of submerged cultural resources, the most significant is the composition of the seabed in which a particular site may lie.[18] Of secondary importance are such factors as the depth, salinity, temperature, movement and oxygen content of the ambient water column, biogrowth, sea bottom slope and human interference. In the region between Deer and Castle Islands under consideration for the fixed cable crossing, the sea bottom is composed primarily of glacially deposited clay overlaid with coarser silt and/or sand. The MLW water depth varies from a minimum of 1 foot at Governors Island Flats to a maximum of 38 feet at the outward bound side of the Main Harbor Channel adjacent to Castle Island. The main run for the cable between the two islands comprises the Deer and Governors Islands Flats, which average less than 10 feet in depth at MLW, with isolated pockets up to 27 feet deep. Inner harbor water salinity is diluted by the Mystic and Chelsea Rivers' outflow; the temperature is classified as normal. Dissolved oxygen levels and general water quality are low, on account of numerous pollutants ranging from raw sewage discharge to oil spills.[19] Human interference, including historic harbor and airport improvement projects, shellfishing and disturbance to the harbor bottom from 350 years of general shipping acitivity, is extremely high. Local storms, concentrated upon the exposed inner harbor flats, also are likely to have had a significant impact upon sea bottom conditions in this region due to the shallow water depth.

---

[18] For a general discussion of the various factors, see Muckelroy, 1978: 160ff.

[19] Army Corps of Engineers, op. cit., EA-10 through EA-22.

In general, the physical sea bottom characteristics, consisting of the clay substrate overlaid with sand and/or silt, combined with the oxygen-reducing pollutants, would provide favorable conditions for wrecksite preservation. However, these factors are far outweighed by the manifold unfavorable ambient conditions such as shallow water depth, storms and various forms of human interference outlined above. As a result, the overall effects of inner harbor bottom characteristics and conditions may be generally summarized as extremely unfavorable for the preservation of submerged cultural resources.

6. The Impact of Fixed Cable Laying on Historic Wrecksites

For this section of the report, five documents supplied by Stone & Webster Engineering Corporation were utilized to determine the potential impact of the cable laying and trenching operation across inner Boston harbor.[20] The technology presently under consideration for this phase of the project is a new one, involving a remote-operated trenching sled under tow by a surface support barge. The barge uses a six-point mooring system to kedge itself and the sled over the cable pathway. At the bow of the sled are a variety of trenching tools, ranging from injectors with water jets that can cut through soft substrate to rock saws, hydraulic power chisels and wide carbide-tipped cutters that are capable of trenching through a hard rock matrix.[21] Current plans indicate that the trenches will total 30,000

[20] Grainger, 1987; Harmstorf Corporation, n.d., McGraw, 1982, Mills, 1988 and Okonite Corporation, 1987.

[21] McGraw, 1982 and Harmstorf Corporation, n.d. Harmstorf Corporation, n.d.:11 indicates that

feet in length by 10 feet in depth and 30 inches in width.[22]

Based upon the information available to date, there can be little doubt that the operation of the cable trenching and laying sled would have a maximum adverse impact upon any cultural materials directly within its pathway. Although the proposed trench width is three meters deep and less than one meter wide, the impacted area would be widened by the overall width of the sled, which moves on long-toothed treads for maximum traction (*how wide is the sled?*). In addition, the incremental setting and moving of the six-point surface barge moorings, as well as moorings and/or anchorings of other surface support or supply vessels, would widen the impacted pathway to presently indeterminate levels.

In summary, it is unlikely that any cultural resources located directly along the cable pathway or around the support barge moorings would survive the cable trenching and laying operation. By contrast, any sites located even marginally beyond these parameters would not likely be impacted at all.

7. Recommendations for Future Follow-up Work

A survey of the documentation available for submerged cultural resources within the pathway(s) of the proposed fixed cables to Deer Island has located no sites of potential historic or archaeological significance. Furthermore, for the reasons cited above, it is unlikely that such sites, if

---

the injector water jets operate at 230 psi

[22] Grainger, 1987 and Mills, 1988.

extant, would be sufficently well preserved to warrant full-scale scientific excavation, on account of more than a century of widespread harbor improvement projects, the construction of Logan International Airport, and general high-density shipping activity throughout the harbor's past. Nevertheless, certain additional steps may be taken to ensure the absence of historic sites in the area under investigation and/or the condition and integrity of any sites that may exist.

Additional documentary resources beyond those cited in the attached bibliography could be consulted either through exhaustive, incremental or random sampling to ascertain whether any historic sites existed. Such sources might include local and régional daily, weekly and monthly newspapers and magazines, insurance company records and claims reports, law court records and transcripts, wharf records and the like (if extant). However, this course of action would be prohibitively costly and time-consuming if undertaken prior to the location and identification of potentially impacted sites.

A field survey could be conducted in those areas for which the potential cultural impact of the fixed cable project is greatest. In this regard, the most significant area would be the region around the northwestern shore of Deer Island, where cable routes S1, S2 and N3 converge (see Figure 1). As discussed above in Section 4, this area is closest to the topographical feature once known as Shirley Gut, through which documented historic shipwrecks from the eastern shores of Winthrop and Deer Island may have

washed prior to closure in the 1930s. If undertaken, the field survey should extend from the Deer Island fixed cable terminal northward along cable route N3 for a distance of approximately 1,750 yards, ending between the Winthrop buoy and the easternmost boundary of Logan Airport. There is little (if any) value in extending a field survey beyond this point or along cable routes S1 and S2 on account of the past history of widespread harbor improvements and general activity.

The most efficent and cost-effective field survey procedure would combine a reconnaissance-level magnetometer search with sonar and sub-bottom profiling capability. Any available information on pre-existing power, sewage and telephone lines, pipelines or cables should be documented before a field survey to facilitate and expedite operations and eliminate unnecessary activity. Appropriate anomalies recorded by the field survey should be further investigated by means of diver reconnaissance.

Wrecksites located during the course of the field survey which are determined by National Register criteria to be of historic or archaeological significance by the regulatory agency (the Massachusetts Historical Commission) should be avoided. Due to the time and expense incurred by scientific excavation of an historic wrecksite, which would be required by state (and possibly federal) regulations, significant sites located within the cable pathway(s) should be left intact, and the cable(s) should be placed at a sufficient distance so as to protect the resource(s) during construction.

Prior to any field survey, the State Archaeologist, the State Historic Preservation Officer, the Massachusetts Board of Underwater Archaeological Resources, and the US Army Corps of Engineers should be consulted and any necessary permits obtained therefrom.

8. Bibliographical Sources

Anonymous, **Annual Report of the Humane Society of the Commonwealth of Massachusetts**. Boston: The Press of Nathan Sawyer & Son and various publishers, 1886-1976

__________, **Awful Calamities or the Shipwrecks of December 1839....On the Coast of Massachusetts**. Boston: J. Howe, 1840

__________, **Notice To Mariners**. Washington, DC: U.S. Navy Hydrographic Office, 1971-1988 (weekly)

__________, **22nd Annual Report of the Boston Port Society**. Boston: Eastburn's Press, 1851

Army Corps of Engineers, **History of Boston Harbor 1825-1907**. Washington, D.C.: Government Printing Office, 1825-1908(?). Excerpts from annual reports bound in 2 volumes; in library of US Army Corps of Engineers, New England Division, Waltham, MA

__________, **Boston Harbor, Massachusetts: Feasibility Report and Environmental Assessment for Deep-draft Navigation Improvements to Boston Harbor Including Mystic River, Chelsea River and Reserved Channel.** Waltham, MA: US Army Corps of Engineers, New England Division, 1988

__________, **Project Maps: Rivers and Harbors: Massachusetts.** Waltham, MA: US Army Corps of Engineers, 1976. 2 vols.

__________, **Boston Harbor, Massachusetts: Feasibility Report on Debris Removal.** Waltham, MA: US Army Corps of Engineers, New England Division, 1980. 2 vols.

Cahill, R., **Finding New England Shipwrecks and Treasures**. Peabody: Chandler-Smith Publishing House, 1984

Clapp, E.J., **The Port of Boston**. New Haven: Yale University Press, 1916

Delgado, J. P. et al., "Nominating Historic Vessels and Shipwrecks to the National Register of Historic Places," **National Register Bulletin 20**. Washington, DC: U.S. Department of the Interior, National Park Service, Interagency Resources Division, 1987

Duggan, W. and W. Bradbury, **A Partial List of Known Shipwrecks Along The North Shore and in Boston Harbor.** Winthrop/Lynn: Unpublished Typescript in Phillips Library, Peabody Museum of Salem, n.d.

Editors, **Wrecks and Casualties**. Paris: Bureau Veritas, 1900-1949

Forbes, R.B., **Notes on Some Few of the Wrecks....and Rescues during the Present Century**. Boston: Little, Brown & Company, 1889

__________, **Report to the Boston Board of Trade....on the Subject of Seamen and Marine Disasters**. Boston: Boston Journal Office, 1855

Grainger, K.A., pers. comm. to E.F. Geary, Boston Edison, 11 September 1987

Harmstorf Corporation, **Sub-sea Rock Trenching.** New York: Harmstorf Corporation, n.d. (ca. 1986) 1-11

Howland, S.A., **Steamboat Disasters and Railroad Accidents in the United States.** Worcester: Dorr, Howland & company, 1840

Huntress, K.G., **A Checklist of Narratives of Shipwrecks and Disasters at Sea to 1860**. Ames, IO: Iowa State University Press, 1979

__________, **Narratives of Shipwrecks and Disasters 1586-1860**. Ames, IO: Iowa State University Press, 1974

Jenney, J., **Shipwrecks of New England: Lure and Lore.** Milwaukee: Rose Publications, 1981

Lonsdale, A.L. and H.R. Kaplan, **A Guide to Sunken Ships in American Waters.** Arlington, VA: N.P., 1964

Luther, B.W., **The Vanishing Fleet: Massachusetts-Rhode Island Shipwrecks.** N.P.:B.W. Luther, Jr., 1965

__________ and E. Weeks, **New England Shipwrecks**. Boston: B.W. Luther, 1967

McGraw, M., "Utility Methods. Robot-like Subsea Sled Overcomes 40-ft Tides," **Electrical World** March 1982: 145-48

Mills, A., **MWRA Secondary Facilities Planning Memorandum** to D. Viscardi, 15 April 1988

Mitchell, C.B. (ed.), "The Lytle-Holdcamper List," **Merchant Steam Vessels of the United States 1790-1868.** Staten Island: The Steamship Historical Society of America, Inc., 1975 (2nd Edition) 237-308

Muckelroy, K., **Maritime Archaeology**. Cambridge: Cambridge University Press, 1978

Nalty, B.C. (ed.), **Wrecks, Rescues & Investigations. Selected Documents of the U.S. Coast Guard and its Predecessors**. Wilmington, DE: Scholarly Resources, Inc., 1978

Okonite Company, Drawing 1A, last dated 16 June 1987

Quinn, W.P., **Shipwrecks Around New England**. Orleans, MA. Lower Cape Publishing Company, 1979

Roberts, M. (ed.), **Summary and Analysis of Cultural Resource Information on the Continental Shelf from the Bay of Fundy to Cape Hatteras**. Cambridge, MA: Institute of Conservation Archaeology, 1979. 4 vols.

Smith, F.-H., **Storms and Shipwrecks in Boston Bay and the Records of the Lifesavers at Hull**. Boston: Private Printing, 1917. = Bostonian Society Publication vol. II, Second Series

Snow, E.R., **Great Storms and Famous Shipwrecks of the New England Coast**. Boston: The Yankee Publishing Company, 1943

________, **The Islands of Boston Harbor: History and Romance 1626-1935**. Andover, MA: The Andover Press, 1935

________, **Marine Mysteries and Dramatic Disasters of New England**. New York: Dodd, Mead & Company, 1976

________, **New England Sea Tragedies**. New York: Dodd, Mead & Company, 1960

Sweetser, M.F., **King's Handbook of Boston Harbor**. Cambridge, MA: M. King, 1883

United States Life-Saving Service, **Annual Reports of the U.S. Coast Guard**. Washington, DC: Government Printing Office, 1876-1932

U.S. Coast Guard, **Principal Marine Disasters 1831-1932**. Washington, DC: Public Information Division, n.d.

Works Project Administration, **Boston Looks Seaward: The Story of the Port**. Boston: Bruce Humphries Inc., 1941

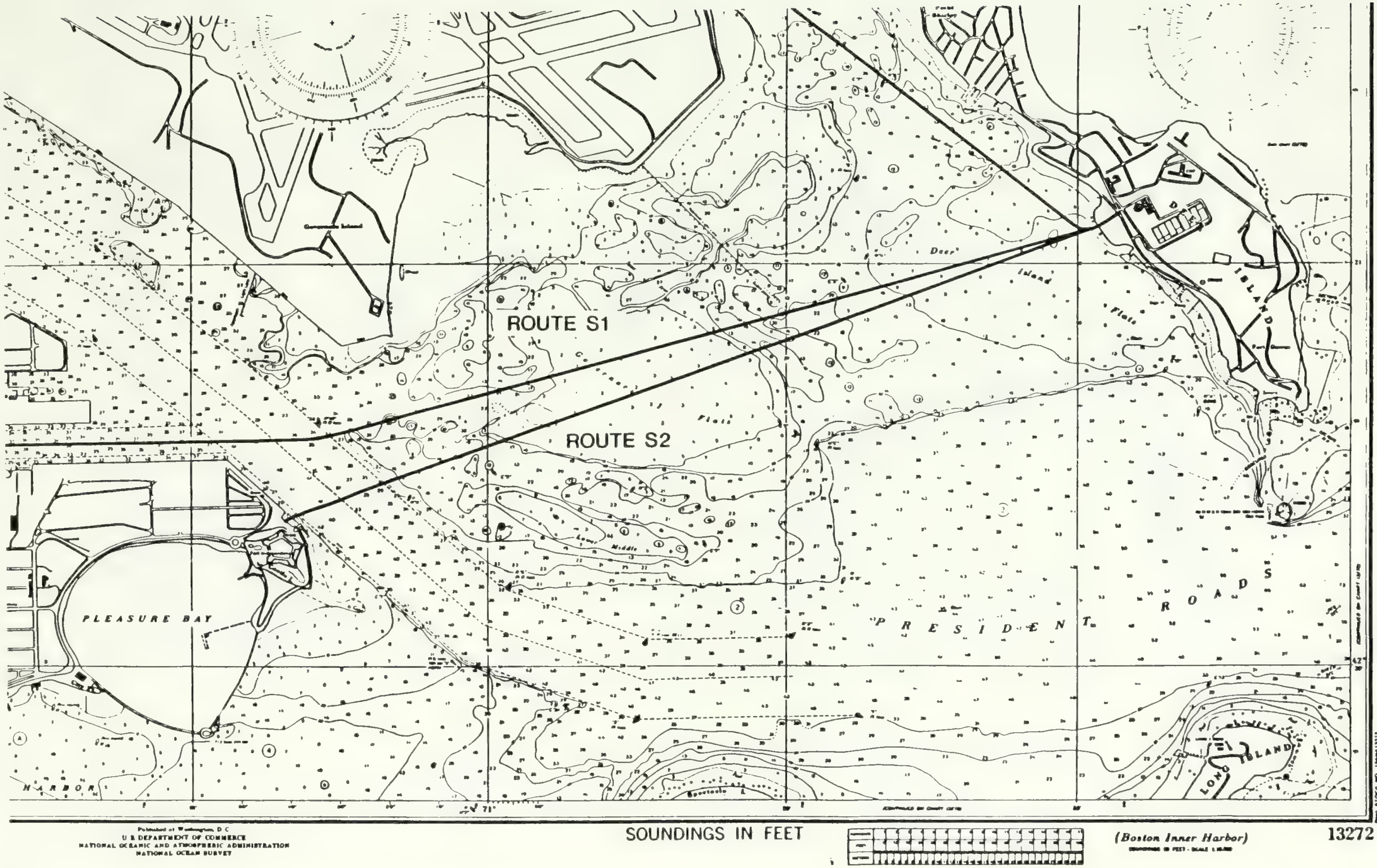


Figure 1. Chart of Boston Inner Harbor with bmarine Cable Routes

A.

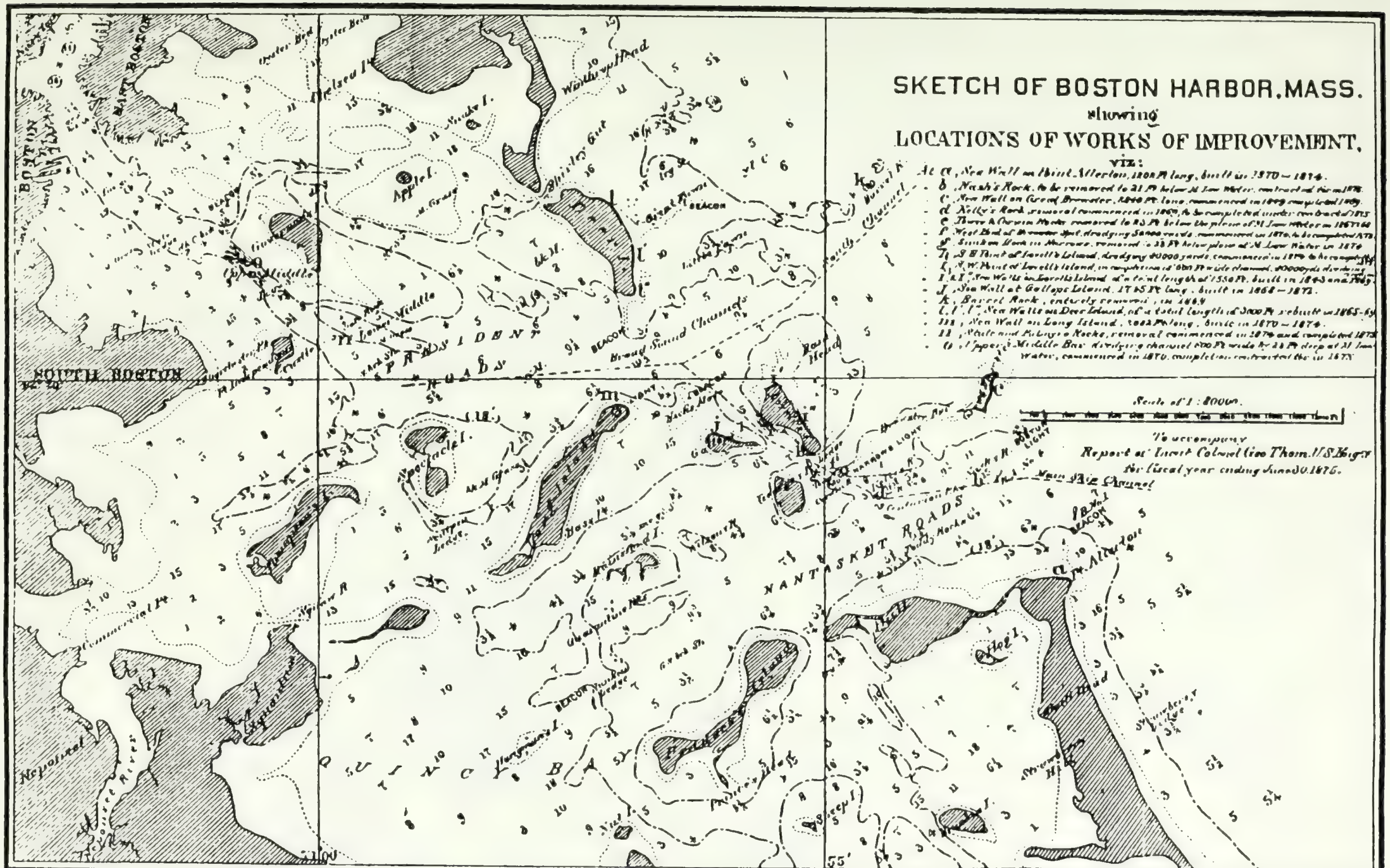


Figure 2. 1875 Sketch of Boston Harbor showing harbor improvements, oyster beds and Shirley Gut.

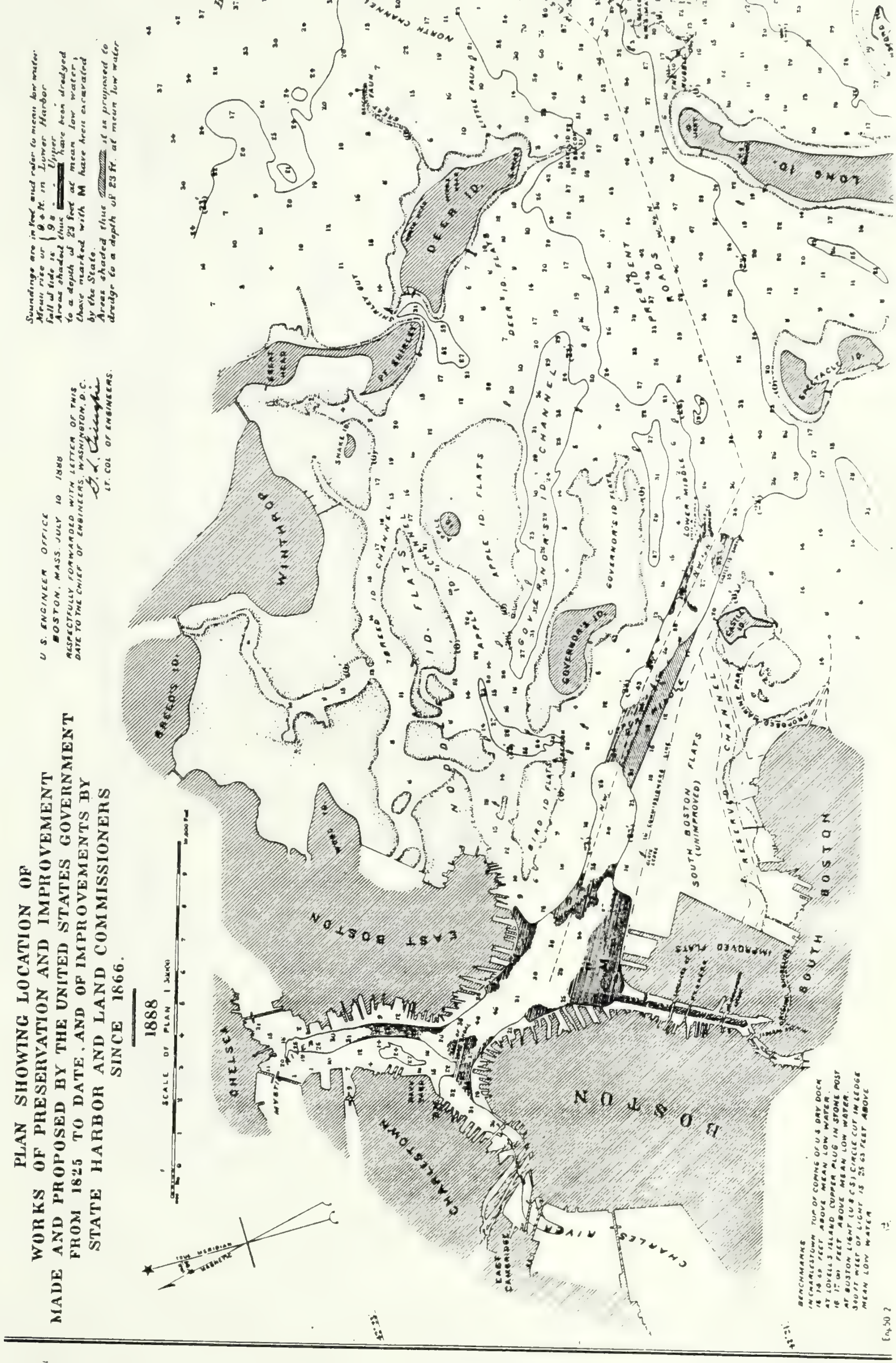


Figure 3. 1888 Plan of Boston Harbor showing inner harbor islands, flats, channel dredging and proposed Castle Island improvements.

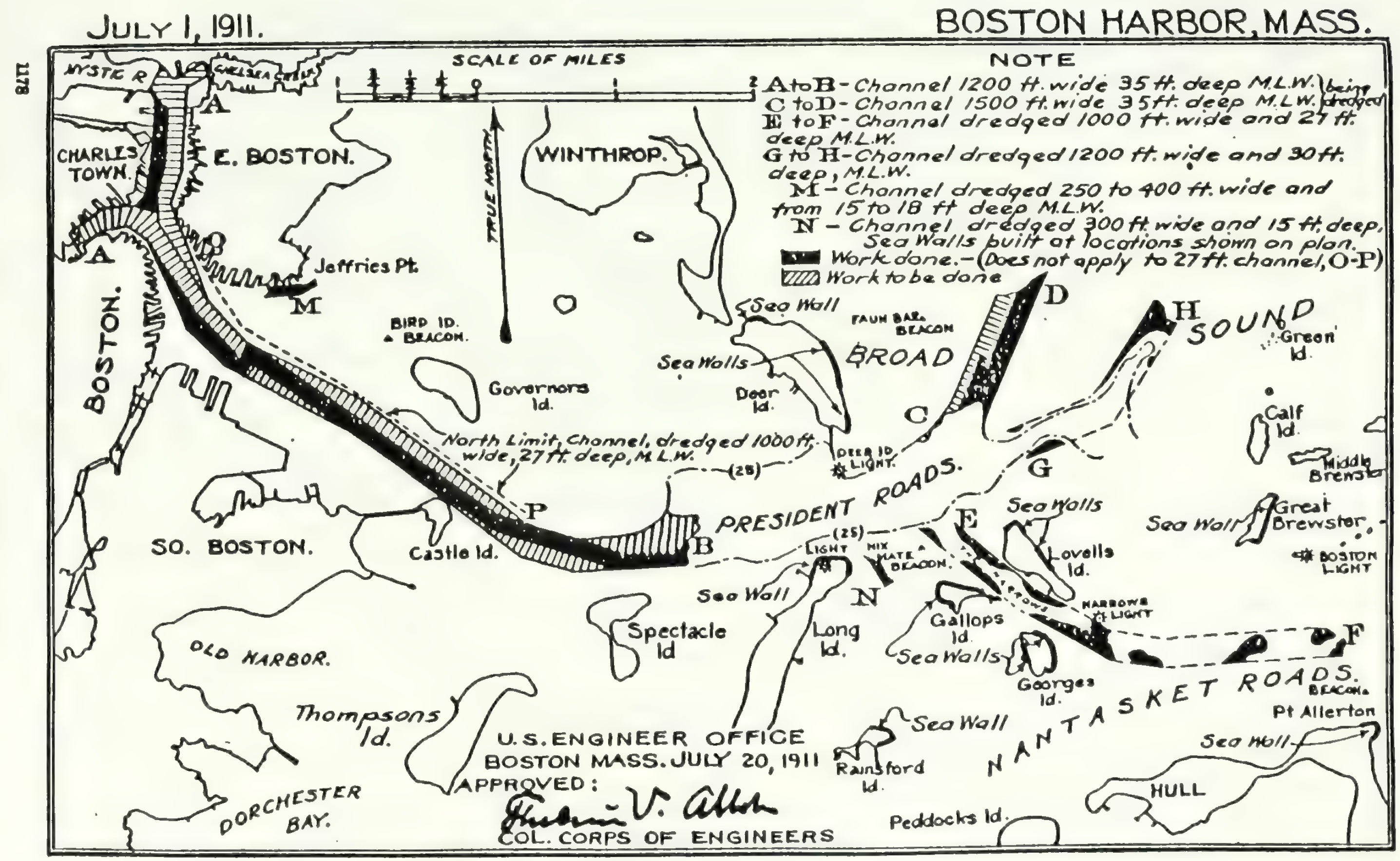


Figure 4. 1911 map of Boston Harbor, showing inner and outer harbor improvements, completed and proposed.

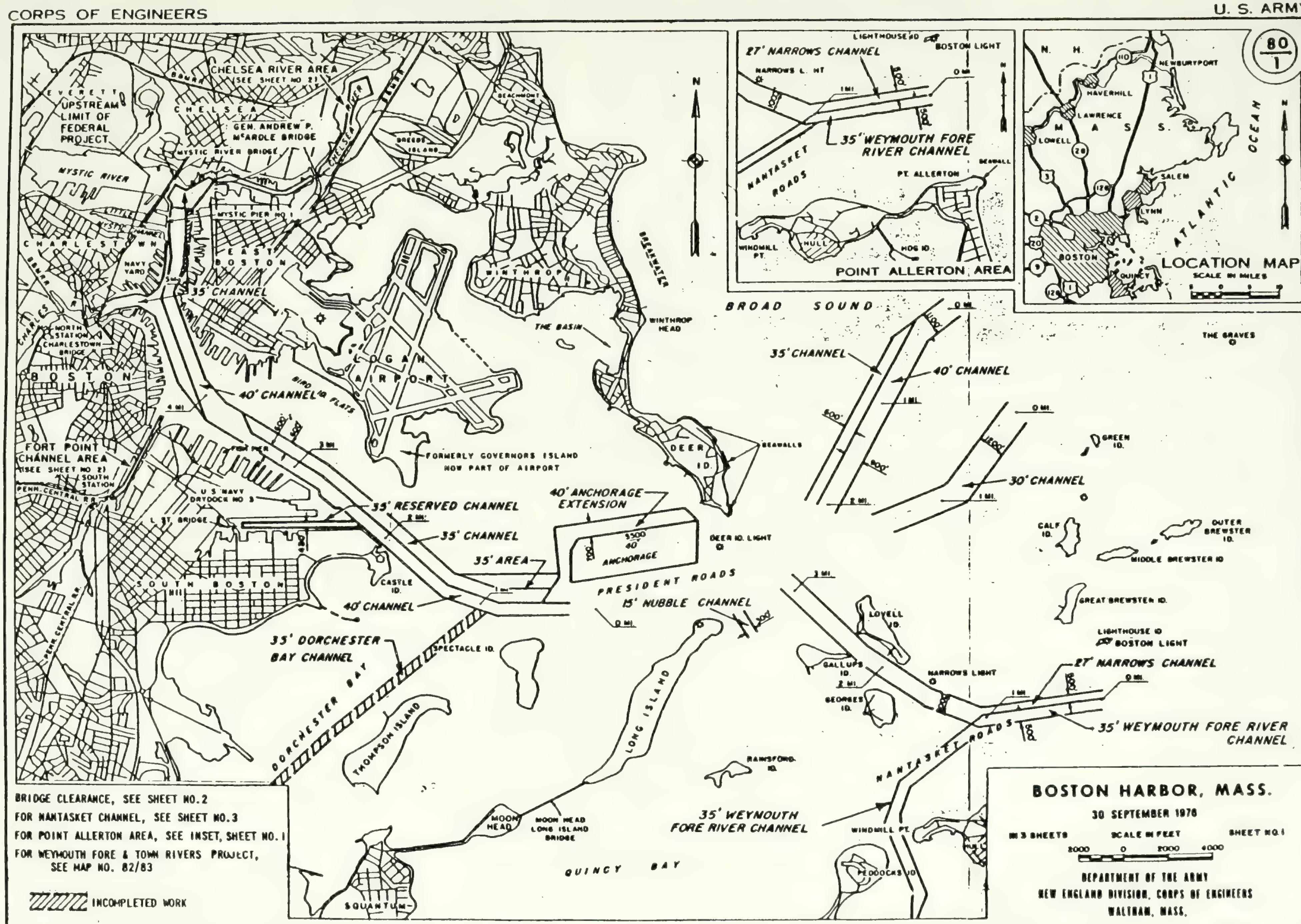


Figure 5. 1976 map of Boston Harbor, showing present channel configurations.

SECONDARY TREATMENT FACILITIES PLAN
SUPPLEMENT TO APPENDIX H, VOLUME III

APPENDIX D

HISTORIC AND ARCHAEOLOGICAL RESOURCES

DEER ISLAND TREATMENT FACILITIES
OFF-ISLAND UTILITY SUPPLY

HISTORIC AND ARCHEOLOGICAL RESOURCES

Prepared By

Stanley Moss
Pauline Chase Harrell

Boston Affiliates, Inc.
156 Milk Street
Boston, Massachusetts 02109

In Association With

Victoria Bunker, Consulting Archeologist

For

Camp, Dresser & McKee, Inc.
One Center Plaza
Boston, MA 02108

May 23, 1988

DEER ISLAND TREATMENT FACILITIES

OFF-ISLAND UTILITY SUPPLY

HISTORIC AND ARCHAEOLOGICAL RESOURCES

1.0 EXISTING CONDITIONS - HISTORIC AND ARCHAEOLOGICAL RESOURCES

The proposed routes for the utility supplies pass through a variety of developed, recreational and open areas in East Boston, South Boston, Chelsea, Revere and Winthrop. Since these communities contain archaeological and historic sites dating from settlements in prehistoric as well as historic periods, they were examined for sites which might be impacted by the proposed utility lines.

Identification of Historic Resources Information on historic sites was gathered by means of field inspection of the routes, as well as review of the State Register of Historic Places, Reconaissance Survey Reports published by the Massachusetts Historical Commission (MHC), and maps and inventory forms on file at the MHC. Of the areas examined, South Boston has been surveyed intensively, Revere and Chelsea have been surveyed selectively in areas where historic buildings are concentrated, and Winthrop and East Boston have not been surveyed.

By means of the field inspection and review of available sources, known historic sites were identified, and potential resources

located. Since the level of impacts along the route of the utility lines is for the most part low, extensive research on potential sites was not pursued.

Section 1.1 describes historic resources using the following definitions:

> Listed on NR: Listed on the National Register of Historic Places (36CFR60), a list of properties of local, state or national significance designated by the Department of the Interior through the State Historic Preservation Officer
>
> Potentially Eligible for NR: A property which appears to meet the criteria for listing on the National Register, but which has not been nominated.
>
> Boston Landmark: A property of local and state or national significance which has been designated as a landmark by the Boston Landmarks Commission.
>
> Potential Resource: A property which appears to have historic significance, but for which research has not yet been undertaken to determine whether it meets criteria for listing on the National Register.

Identification of Potential Archaeological Resources Section 1.1 presents the results of initial archaeological survey for locations to be affected by the proposed installation of underground utility

supplies. Existing conditions and areas of potential archaeological sensitivity are described for the alternative routes. An assessment of impact on archeologically sensitive locations is made. Interpretations are based on observed surface conditions from a drive-over survey conducted on April 22, 1988.

The proposed routes include primarily segments within existing roadways. These segments have already been extensively modified by modern activity including cutting, filling, placement of utilities and paving. The proposed trenches for the new utility lines will not exceed seven feet in depth below the current ground surface; this depth is believed to coincide with extant disturbance levels.

Areas of potential historic and prehistoric archaeological sensitivity may exist elsewhere along the proposed alternative routes in areas such as shoreline and open locations where the effects of modern land use are believed to be limited and resources may be preserved intact. These areas have been identified through surface inspections only. Documentary research may refine interpretations.

An Appendix to this report provides further information on methods, project description, the archaeological context and resource potential.

1.1 Historic and Archaeological Resources along Routes of Interim and Permanent Power, Potable Water and Gas Mains

Route N-1 (Start at BECo Chelsea Substation-Eastern Avenue-Broadway-Revere Beach Parkway-Winthrop Avenue-Revere Street-Crest Avenue-Winthrop Shore Drive-beach all the way to Shirley Point-Deer Island)

Historic Resources

Chelsea

1. Mary C. Burke School (220 Spencer Avenue). ca. 1881 Tudor-style public school which survived Fire of 1908. Potential resource.

Revere

2. Slade Spice Mill (Revere Beach Parkway). 1734 tidal mill, three-story timber structure. Closest building edge to the street is approximately 20 foot from the building line. Listed on the National Register of Historic Places (NR).
3. Battle of Chelsea Creek Site (Revere Beach Parkway). Site of the second battle of the American Revolution, May 27, 1775. Open waterfront site owned by the Metropolitan District Commission. Potential resource.
4. Fire Station (Winthrop Avenue between Summer and Webster Streets). 1920s Tudor-style. Potential resource.
5. St. Pauls Episcopal Church (Winthrop Avenue. corner of Webster Street). 1887 stone and wood church. Potential resource.
6. Trinity Congregational Church (855 Winthrop Avenue). 1882 timber structure, no longer used for religious purposes.

Potential resource.

Winthrop

No sites identified

Archaeological Resources

Chelsea-Revere

A. Mill Creek Location is on Broadway at crossing of Mill Creek. Possible resources are historic or prehistoric stream banking loci. Resource potential is low due to modern and historic filling.

Revere

B. Battle of Chelsea Creek Site Location is stream bank between the Revere Beach Parkway and stream. Possible resources are historic resources from battle site. Resource potential is low due to modern roadway construction.

C. Sales Creek Location is on Revere Beach Parkway where the Parkway crosses over Sales Creek, channeled at that point in a culvert. Possible resources are historic or prehistoric stream banking loci. Resource potential is low due to modern and historic filling.

Winthrop

D. Winthrop Shore Drive at Sea Wall Location is at Winthrop Shore Drive and sea wall on open beach margin, presumably disturbed by construction of the sea wall. Possible resources are dispersed prehistoric or historic loci on open beach.

Resource potential is low due to open setting and road/wall construction.

Ea. Shirley Point Location is at Shirley Point connection to Deer Island, not in roadway. Possible resources are prehistoric or historic loci on shoreline. Resource potential is moderate if former shore line is filled over original undisturbed flats.

Route N-1A (Start at BECo Chelsea Substation-Eastern Avenue-Broadway-Revere Beach Parkway-Winthrop Avenue-Revere Street-Locust Street-Winthrop Shore Drive-beach all the way to Shirley Point-Deer Island)

Historical Resource

Sites 1 - 6 described above

Archaeological Resources

Sites A - Ea described above

Route N-1B (Start at BECo Chelsea Substation-Eastern Avenue-Broadway-Revere Beach Parkway-Winthrop Avenue-Revere Street-Shirley Street-Veterans Road-Shirley Street all the way to Shirley Point in roadway-Deer Island)

Historic Resources

Sites 1 - 6 described above, and

7. Deane Winthrop House (40 Shirley Street). 1637 woodframe house. Closest edge to the street is a few feet from the building line. An important early house, included in the

Thematic Survey of First Period Houses in Eastern Massachusetts, on file at the MHC pending nomination to the NR. Eligible for listing on the NR.

8. Winthrop Yacht Club (Shirley Street). 1904 Shingle-Style building designed by Willard Bacon. Potential resource.

Archaeological Resources

Sites A - E described above, except that location at Shirley Point is in roadway.

Eb. Shirley Point Location is at Shirley Point connection to Deer Island in roadwa. Possible resources are prehistoric or historic loci on shoreline. Resource potential is low due to road construction.

Route N-1C (Start at BECo Chelsea Substation-Eastern Avenue-Broadway-Revere Beach Parkway-Winthrop Avenue-Revere Street-Crest Avenue-Winthrop Shore Drive-Tewksbury Street-Shirley Street all the way in roadway to Shirley Point-Deer Island)

Historic Resources

Sites 1 - 6 and 8 described above, and

9. Union Congreational Church (22 Tewkesbury Street). Late 19th century building of masonry and timber, with tower. Potential resource.

Archaeological Resources

Sites A - Eb described above.

Route N-1D (Start at BECo Chelsea Substation-Eastern Avenue-Broadway-Revere Beach Parkway-Winthrop Avenue-Revere Street-Crest Avenue-Winthrop Shore Drive-beach all the way to Adams Street-Tafts Street in roadway-Deer Island)

Historic Resources

Sites 1 - 6 described above.

Archaeological Resources

Sites A - Eb described above

Route N2 (BECO Chelsea Substation-Eastern Avenue-Marginal Street-conduit under Chelsea River-Condor Street-Shelby Street-Princeton Street-Neptune Street-Bennington Street-Trident Street-Orient Heights Beach-Boston Harbor)

Historic Resources

Chelsea

No sites identified

East Boston

10. American Legion Playground (Condor and Glendon Street). Early 20th century brick recreational building and playground. Potential resource.
11. House (360 Bennington Street). Early 19th century two and a half story timber frame house. Potential resource.
12. Bennington Street Cemetery (Bennington Street, corner of Swift Street). 1838 historic cemetery, with immigrant associations. Tombs are located close to boundary wall on

Bennington Street. Potential resource.

13. St. Mary's Star of the Sea School, Convent and Rectory (50, 58, 63 Moore Street, corner of Bennington Street). Late 19th century brick church complex. Potential resource.

Archaeological Resources

Chelsea-East Boston

F. Chelsea Creek Location is crossing of river from Marginal Street in Chelsea to Condor Street in East Boston, including wharf and filled areas on flats in highly industrialized setting. Possible resources are historic wharves or piers and prehistoric loci on former shore line. Resource potential is low due to historic filling.

East Boston

G. Orient Heights Beach Location is transecting filled parking lot and beach to water. Possible resources are prehistoric or historic shoreline loci on filled and natural cove. Resource potential is moderate if beach is filled over original undisturbed flats.

Route S1 (BECO K-Street Substation-Reserved Channel)

Historic Resources

South Boston

No historic sites identified

Archaeological Resources

H. Reserved Channel Location is entry to Channel near granite sea wall. Possible resources are historic walls and wharves. Resource potential is moderate if resources are preserved beneath fill.

Route S2 (BECo K-Street Substation- K-Street-East Broadway- Day Boulevard-Castle Island)

Historic Resources

South Boston

14. Pilgrim Hall (732-34 East Broadway). 1890 mixed-use commercial space with meeting hall; a fine example of a Queen Anne/Romanesque Revival masonry building. Potentially eligible for listing on the NR.
15. Harrison Loring House (789 East Broadway). Ca. 1864 French-Italianate brick with brownstone trim mansion house. A Boston Landmark; potentially eligible for listing on the NR.
16. Independence Square Residential District (Bounded roughly by L, East 2nd, N and East 5th Streets). Late 1850s to 1880s district of row houses and detached mansions grouped around two parks. Recommended as a Boston Landmark District; potentially eligible as an NR district.
17. City Point District (Bounded roughly by Farragut Road, East 3rd Street, P Street and East 6th Street). Nineteenth and early 20th century district of freestanding mansions and rowhouses.

Recommended as a Boston Architectural Conservation District; potentially eligible as a NR district.

18. Castle Island Waterfront District. This landscaped waterfront district is part of the water frontage stretching approximately two and a half miles from Columbia Park to Castle Island. It has historical associations with the late 19th century municipal park system designed by Frederick Law Olmsted. Potentially eligible as an NR district.

19. Fort Independence (Castle Island). 1801-9 military fort, the oldest continuously used British military fortification in the United States, with antecedents going back to 1634. Listed on the NR; recommended for designation as a Boston Landmark.

Archaeological Resources

South Boston

I. Pleasure Bay Beach Location is Pleasure Bay Beach along road and shoreline; beach is artificial fill over shale. Possible resources are prehistoric or historic shore line loci, with small dispersed activity areas likely. Resource potential is low due to road construction and fill.

J. Fort Independence Location is north side of the park in vicinity of original sea wall, planted grass and trees, and MassPort property. Possible resources are historic walls and deposits at shoreline associated with repeated fort habitation. Resource potential is high, if preserved by fill.

2.0 EVALUATION OF ALTERNATIVES - HISTORIC AND ARCHAEOLOGICAL RESOURCES

Routes were evaluated for their potential impact on historic and archaeological resources by applying the following criteria:

High impact - In terms of historic resources, routes of potentially high impact are considered to be those which will result in permanent damage to the building . This may be the case where the routes will pass close to buildings, possibly threatening their structural integrity by trenching and other construction impacts; or where trenching will disturb or require the removal of original building fabric. In terms of Section 106 of the National Historic Preservation Act, "high impacts" are considered adverse effects.

In terms of archaeological resources, impact from construction is generally high, because of the fragile and systemic nature of archaeological resources. Any impact which completely modifies an archaeological site is considered high, due to the non-renewable nature of sites.

Moderate impact - In terms of historic resources, impact on buildings will not threaten structural integrity, but will have temporary impacts of traffic diversion, disruption of access, noise, dust and vibration during construction. Paving will be

cut with saws, not jackhammers, and thus construction impacts to buildings along the routes will not be severe. Since the utility supply lines will be buried for their entire length, no long-term negative effects are expected. In terms of Section 106 of the NHPA, "moderate impacts" are not considered adverse.

Because no impact to an archaeological site is temporary, only impact to a portion of a site may be considered a moderate impact.

Low impact - No significant impacts are anticipated.

Route N-1

Historic Resources This route will have moderate impacts where it passes the Mary C. Burke School, Battle of Chelsea Creek Site and the three sites on Winthrop Avenue in Revere; impacts on the Slade Spice Mill will also be moderate and temporary provided that the recommended mitigation measures are followed.

Archaeological Resources At the Mill Creek site, there will be no impacts as the supply lines will be suspended below the bridge and not buried underground. At the Battle of Chelsea Creek site, the impact will be moderate. There will be no impacts at Sales Creek as the stream runs in a culvert, and the utility lines will be placed

in the roadway above the culvert. Impacts at the sea wall site in Winthrop will be low because of the installation of the utility lines close to the sea wall footings. At Shirley Point, the impacts will be moderate since in this alternative the route is not in the roadway.

Route N-1A

Historic Resources Impacts will be the same as for Route N-1.
Archaeological Resources Impacts will be the same as for Route N-1.

Route N-1B

Historic Resources Impacts will be the same as for Route N-1, with the following additions: The Revere Street-Shirley Street route will have a moderate and temporary impact where it passes the Deane Winthrop House, provided that the recommended mitigation measures are followed. The route will also have a moderate impact where it passes the Winthrop Yacht Club
Archaeological Resources Impacts will be the same as for Route N-1, except that there will be no impacts at Shirley Point as the utility lines will run in the roadway.

Route N-1C

Historic Resources Impacts will be the same as for Route N-1, with the following additions: Moderate impacts are anticipated at the Union Congregational Church on Tewkesbury Street and the Winthrop

Yacht Club on Shirley Street.

Archaeological Resources Impacts will be the same as for Route N-1, except that there will be no impacts at Shirley Point as the utility lines will run in the roadway.

Route N-1D

Historic Resources Impacts will be the same as Route N-1.

Archaeological Resources Impacts will be the same as for Route N-1, except that there will be no impacts at Shirley Point as the utility lines will run in the roadway.

Route N-2

Historic Resources Moderate impacts for all the sites in East Boston identified on this route.

Archaeological Resources At Chelsea Creek, there will be no impact because the power lines will be laid in an existing conduit under the river. At Orient Heights Beach, the impact will be moderate due to the short distance across the beach.

Route S1

Historic Resources Low impact, as there are no resources between the substation and the Reserved Channel.

Archaeological Resources Impacts will be moderate due to the short distance across the site.

Route S2

Historic Resources Moderate impacts for the sites and historic districts in South Boston on this route; potentially high impact for the route through the Fort Independence area, depending on the actual alignment of the route through the property.

Archaeological Resources At Pleasure Bay Beach, impacts will be moderate on the beach, and there will be none on the roadway. At Fort Independence, impacts will be high due to the proximity of the route to the original sea wall.

3.0 RECOMMENDED PLAN - HISTORIC AND ARCHAEOLOGICAL RESOURCES

Preferred alternatives from the point of view of historic and archaeological routes are:

Routes N-1, N-1A, N-1B, N-1C and N-1D

Historic Resources All alternative routes except the Shirley Street segment where the route passes the Deane Winthrop House are preferred.

Archaeological Resources In-road construction will not affect potential resources. Along open water, scattered historic or prehistoric loci may be found. Construction along the sea wall may have effects upon archaeological resources. The length of this segment would entail a substantial archaeological survey effort. Similarly, construction outside of the roadway at Shirley Point may have effects upon resources, and an archaeological survey must be undertaken.

Summary The Revere Street-Shirley Street segment is the least desirable alternative because of potential impacts on the Deane Winthrop House; the segments along the sea wall and outside of the roadway at Shirley Point are undesirable because of potential impacts on resources and the need to survey them further. All other segments will have low impacts.

Routes N-1 and N-2

Historic Resources Route N-2 through East Boston is preferable to

Route N-1, which passes the Slade Spice Mill and, in one variation, the Deane Winthrop House.

Archaeological Resources Historic or prehistoric loci may be found on any shore lines or stream margins. In the proposed project, the utility supplies will cross the Mill Creek suspended under the existing bridge, and Sales Creek in the roadway above the existing culvert. The route on Revere Beach Parkway will pass the Battle of Chelsea Creek Site in the existing roadway. An existing conduit under the Chelsea River will carry utility lines under the river without the need for new excavation. The only sensitive area in Routes N-2 is Orient Heights Beach, which will require limited field examination.

Summary Either Route N-1 or N-2 will have low impacts, provided that the mitigation measures recommended for the Slade Spice Mill and Deane Winthrop House are performed, and the archaeological surveys are carried out along the beach and Shirley Point in Winthrop, and Orient Beach in East Boston.

Routes S-1 and S-2

Historic Resources Route S-1 through the Reserved Channel is preferable to Route S-2, which passes several historic buildings, through three historic districts, and through the Fort Independence area.

Archaeological Resources On Route S-1, the extent of sensitive areas is limited to walls and wharves on the edge of the Reserved

Channel; field examination would be limited in nature. Route S-2 passes through Fort Independence, a very sensitive area where extensive archaeology has already been completed. Additional archaeological study would be necessary at Fort Independence, and study over a great linear distance would be recommended along Pleasure Bay.

Summary Route S-1 is preferable to Route S-2, because of potential impacts and additional archaeological study needed at Pleasure Bay and Fort Independence.

4.0 MITIGATION MEASURES - HISTORIC AND ARCHAEOLOGICAL RESOURCES

Historic Resources

Where the route passes all historic properties, construction time should be minimized to reduce noise, impacts of excavation, vibration, dust, and traffic disruption.

Slade Spice Mill: Excavations should be located away from the building, if possible. When existing utilities in the roadway have been identified and final plans and specifications prepared for the segment passing the property, they should be reviewed before construction to ensure that impacts on the building will be minimized. Construction of this segment should be monitored.

Deane Winthrop House: If Shirley Street is selected as a route segment, excavations should be located on the opposite side of the street from the historic house, if possible. When existing utilities in the roadway have been identified and final plans and specifications prepared for the segment passing the property, they should be reviewed before construction to ensure that impacts will be minimized. Construction of this segment should be monitored.

Fort Independence: If the utility route crosses this property, the excavation should be dug in the grass strip between the Massport concrete fence and the seawall. Excavation of the concrete path between the seawall and the Fort is undesirable as it will expose the granite backfill to the seawall, and may necessitate disruption of the historic seawall.

Archeological Resources

Winthrop Shore Drive at Sea Wall, Shirley Point (if outside roadway), Orient Heights Beach and Reserved Channel Proposed mitigation measures are monitoring of construction, combined with sampling and recording. When sites are monitored, an archaeologist is present during construction to record any cultural remains exposed during excavation. The archaeologist collects samples and makes field notations. At the Reserved Channel site, the alignment of the utility route should be kept away from the granite wall.

Pleasure Bay A route along the roadway is preferable to one along the beach. If a beach route is selected, mitigation should consist of subsurface sampling of the beach prior to construction. Subsurface sampling entails the systematic placement of hand-excavated tests according to guidelines for intensive survey prepared by the Massachusetts Historical Commission. If significant resources are found in Pleasure Bay, data recovery including complete excavation is recommended.

Fort Independence Mitigation in this location should consist of detailed archival research and review of existing studies, and subsurface sampling. Subsurface sampling entails the systematic placement of hand-excavated tests according to guidelines for intensive survey prepared by the Massachusetts Historical Commission. If significant resources are found at Fort Independence, data recovery including complete excavation is recommended.

APPENDIX

ARCHAEOLOGICAL RESOURCES OF ALTERNATE PROJECT ROUTES

Prepared by Victoria Bunker, Ph.D., May 5, 1988

Introduction

Background documentary review and field inspection have been undertaken to gain an understanding of potential archaeological resources along proposed alternate off-island utility supply routes for Deer Island treatment facilities. Information was gathered for sensitive locations within the study area in East Boston, South Boston, Chelsea, Revere, and Winthrop, Massachusetts. This Appendix details the archaeological resources which may be expected in certain segments of the alternate routes. Impacts by project construction are discussed in the main body of this report.

Methods

Archaeologically sensitive areas are those believed to contain material or structural remains reflecting man's past historic or prehistoric habitation in a particular location. Remains may include foundations, features and artifacts deposited and preserved in a subsurface context. The material remains and their contextual relationship provide data for interpretation of past human activity and behavior. Should the context of an archaeological site be modified or destroyed, the material items become limited in their interpretive ability.

In this study, the archaeological sensitivity of areas along proposed alternate construction routes was determined using several kinds of information. First, the general archaeological context of the study area was defined. This was based on primary and secondary data sources, specifically site location files and cultural resources management reports for study area towns on file at the Massachusetts Historical Commission. Data were then specifically applied to the proposed alternate routes to identify any potentially sensitive locations in impact areas. This step

included interviews with Thomas Mahlstedt, archeologist for the Metropolitan District Commission, and William Stockinger, archeologist studying Fort Independence. Sensitive areas were then viewed during a field inspection of all alternate project routes. During field inspection topography and contemporary landscape use were studied to obtain an impression of original landscape configuration and any modifications which might have obscured, altered, or preserved archaeological resources.

Archaeological resource potential for segments of the proposed alternative routes was ranked high, moderate, or low. A high ranking was assigned to areas of recorded historic or prehistoric sites or activities if they exhibited visually intact landscape features. A moderate ranking was assigned to areas where sites were expected through analogy to sites recorded elsewhere in the study area. These locations may exhibit some disturbance or may contain sites preserved beneath fill. A low ranking was assigned to areas which exhibited extensive subsurface modification through such activites as cutting, filling, or excavation. Streets generally fall into low potential rank.

Project Description

The proposed construction will include excavation for placement of utility lines to Deer Island. Several alternate routes are under study including routes South Boston, East Boston, Revere, Winthrop, and Chelsea. Several underwater alternative routes are proposed but these are being studied by another archaeologist. Construction will involve excavation of trenches to carry gas, electric and water lines. Either single or multiple-line trenches are proposed. Depending on the number of lines placed in a trench, trench width and depth varied. The minimum size is 4 feet wide by 4 feet deep; the maximum size is 16.5 feet wide by 7 feet deep.

Most construction will be contained in existing roadways where fill and other utilities are found.

Several areas have been recognized as archaeologically sensitive. However, construction will be restricted to roadways or culverts in many of these locations and will not affect potential resources. The locations are summarized in the table below:

Route	Community	Sensitive Areas with No Impact	Sensitive Areas with Potential Impact
N-1	Revere	A. Mill Creek	
	Revere		B. Battle of Chelsea Creek
	Revere	C. Sales Creek	
	Winthrop		D. Sea Wall
	Winthrop		Ea. Shirley Point (not in roadway)
N-1A	see N-1		
N-1B	see N-1, except	Eb. Shirley Point (roadway)	
N-1C	see N-1, except	Eb. Shirley Point (roadway)	
N-1D	see N-1, except	Eb. Shirley Point (roadway)	
N-2	Chelsea-East Boston	F. Chelsea Creek	
	East Boston		G. Orient Heights Beach
S1	South Boston		H. Reserved Channel
S2	South Boston		I. Pleasure Bay Beach
	South Boston		J. Fort Independence

The archaeological contexts of the locations listed above are discussed in the following section.

Archaeological Context

The past decade has witnessed unprecedented vigor in archaeological research in Boston. While antiquarians, amateur archeologists and collectors have amassed information on Boston over the past 100 years, it is only since the 1970s that systematic surveys and research has been undertaken by professional archeologists. As predicted by Dincauze, the myth that no worthwhile sites were left in Boston (1974:39) has been discarded. Indeed, much remains to be learned of Boston's prehistory and early history through archaeological study. This is well demonstrated by the dozens of cultural resources survey and management reports that have been submitted to the Massachusetts Historical Commission throughout the 1980s.

Cultural resources management studies are not without bias, however. Often study areas are small in size and limited by design constraints. Therefore boundaries are defined by development projects and entire cultural components can only be sampled rather than completely studied. Other variables impose greater constraints on archaeological resources within Boston. The first and foremost is the extreme modification of the original landscape by man throughout the historic period. From Boston's earliest historic settlement, man has been cutting, filling and grading to reshape and settle Boston. This has alternately preserved and destroyed archaeological sites of both prehistoric and historic age. Natural factors, including erosion, flooding and fluctuating sea levels, have also obscured the archaeological record. Despite these constraints, knowledge of the archaeological past in Boston is growing. Data are being accumulated which can confirm or refute our cultural constructs and supplement our interpretations of past human habitation in Boston.

Prehistoric Context

Areas of prehistoric site potential in greater Boston include sections of both the Inner and Outer Harbors. Protected streams, islands, mudflats and salt marshes as well as large islands formed from drowned drumlins served as habitation areas throughout prehistory. The attractiveness of the environment is due largely to its rich and varied biota including fish, birds, molluscs and mammals (Shaw et al, 1984). Prehistoric sites have

been discovered throughout the Boston Basin on such land forms where access to diverse resources would have been insured. Sites often exhibit limited use and may have served as stop overs, processing areas, or specialized sites. Sites may also have been situated in marginal settings as optimal locations witnessed intensified use over time.

Boston prehistory is closely linked with reconstruction of past environments. While components dateable to the Paleo-Indian period, the earliest prehistoric period of New England, are not known in Boston, components from all subsequent periods have been recorded. However, marine transgression and creation of Boston Harbor drowned most coastal and estuarine sites approximately 7,500 years ago (Ritchie et al, 1984). Components dateable to all periods of New England prehistory are known in the Boston Basin and include the Early Archaic (10,000 to 8,000 B.P.), Middle Archaic (8,000 to 6,000 B.P.), Late Archaic (6,000 to 3,000 B.P.), Early Woodland (3,000 to 2,000 B.P.), Middle Woodland (2,000 to 1,100 B.P.), and Late Woodland (1,100 to 300 B.P.). Early habitation was probably brief and seasonal in nature. By the Late Archaic period, the Harbor Islands and estuaries were extensively used. The Boylston Street Fishweir was constructed in the Charles River estuary during the Late Archaic period. The site includes wooden stakes set into sediments, presumably for catching fish. It has been preserved by rapid silting in a wet environment and has been protected by the historic fill of Back Bay. The site is significant for its size, integrity, preservation and information on past human behavior. During the Woodland period, shellfish exploitation intensified and large shell midden sites were situated in the estuary. Climatic change and sea level stabilization contributed to the shift in settlement and subsistence. By the Late Woodland period, settlement and subsistence included both the coast and estuary and the off-shore islands. There is some evidence for intensive shell fish collection and farming (Ritched et al, 1984).

Prehistoric sites recorded in the Boston area include lithic quarries, camps, shell middens and villages. Sites are generally located on marshes, brooks, rivers, islands and hills. While no sites have been previously recorded in the immediate project area, several have been identified in close proximity. These include sites on the Neponset River, the Charles River, Boston Common and the Harbor Islands. Two prehistoric burial sites

have been found in Revere and Winthrop. One is a burial on Crescent Beach which was excavated by amateur archeologists in the 1870s. This site is dated to the Middle Woodland period on the basis of such artifacts as a stone platform pipe, a portion of a ceramic vessel and sheets of mica. Other burials found at the site are of later age as determined by the presence of associated European trade material. A cemetery of ten burials was excavated in Winthrop. The site is of Contact period age, as determined by the presence of sheet brass artifacts. The site pre-dates 1634, at which time a cattle pound was erected on the location (MHC, site survey files).

Historic Context

Historic archaeology in Boston involves study of city growth and development. The city's topography has been dramatically altered through extensive cutting and filling in historic times. The archaeological study of chronological change in Boston often focuses on episodes of landscape modification with creation of filled surfaces superimposed on early habitation surfaces. Archaeological sequences have been defined to evaluate and interpret historic sites. This has resulted in development of a culture-historical framework for explaining observed phenomena. Bower and Roberts (1985) have defined four periods for archaeological sites in Boston including Early Settlement (1620-60), Seventeenth Century Town (1660-90), Entrepot (1690-1789), and Federal Port (1790-1830). This sequence reflects social and economic change in Boston. A variety of sites including domestic, public, industrial, commercial and military correspond to all periods in the framework. Site location reflects area growth and changing perspectives in landscape use over time. For example, waterfront areas expanded and were filled over and wharves reached further out into the Harbor, a phenomenon known as "wharving out." The effect is preservation of early wharves beneath later fill, roads, or buildings which were superimposed on made-land.

Historic land use change is documented for various locations in or adjacent to the study area. Extensive filling has occurred in salt marsh areas of Revere which has modified the archaeological context (Bawden, 1979). In other locations, such as Sales and Green Creeks, Revere, original farmland of the 1600s has been highly developed and natural drainages

have been rechanneled with original channels filled (Luedtke, 1976).

The historic use of Deer Island also demonstrates changes through time. The island has served various functions since the 1640s including farmland, pasture, animal pound, Nature American internment, quarantine, recreation, and site of a prison and sewer treatment plant (Randall, 1982; Ritchie et al, 1984).

Military history is also represented in the study area. A U.S. Marine hospital burial ground was excavated on Admiralty Hill in Chelsea which provided complete osteological data on a historic military population (Kelley, 1984). Castle Island in South Boston has served as the oldest continuously fortified site of British North America with its earliest fort erected in 1634. Excavations at several locations on the fort grounds have uncovered features and artifacts associated with several phases of fort use. Primary archaeological deposits may be expected anywhere on the property (Ritchie and Moran, 1976; Stockinger and Moran, 1978). Finally, the Battle of Chelsea Creek, the second battle of the Revolution, was fought on May 27, 1775 on an open waterfront location in Revere.

Sensitive Locations

Documentary data suggest that a variety of types of archaeological resources may be found in the study area. These include prehistoric and historic sites.

Prehistoric sites may represent at least 8,000 years of continuous human habitation. They are expected to be found on the coast, islands, bays, estuaries, and streams. Sites are expected to be modified by historic and modern landscape use and may be disturbed by cutting or filling. Alternately, sites may be preserved by submergence or deep filling.

Historic sites may represent human occupation in Boston during the past 300 years. Sites may include architectural remains, wharves or features from specific activities. Battles may also be represented. Sites are expected to be found both on original and made lands and may be disturbed by cutting, filling, and modern use. Wharves, in particular, are expected to be found beneath fill, superimposed buildings or wharf extensions.

Resource Potential of Study Area

Areas of potential historic and prehistoric archaeological sensitivity may exist elsewhere along the proposed alternative routes in areas such as shoreline and open locations where the effects of modern land use are believed to be limited and resources may be preserved intact.

A. Mill Creek Location is on Broadway at crossing of Mill Creek. Possible resources are historic or prehistoric stream banking loci. Resource potential is low due to modern and historic filling, and the reshaping of Mill Creek.

B. Battle of Chelsea Creek Location is stream bank between the Revere Beach Parkway and stream. Possible resources are historic resources from battle site. Resource potential is low due to modern road construction.

C. Sales Creek Location is on Revere Beach Parkway where the Parkway crosses over Sales Creek, channeled at that point in a culvert. Possible resources are historic or prehistoric stream banking loci. Resource potential is low due to modern and historic filling, and also low due to rechanneling of Sales Creek by the Massachusetts Department of Public Works in 1932.

D. Winthrop Shore Drive at Sea Wall Location is at Winthrop Shore Drive and sea wall on open beach margin, presumably disturbed by construction of the sea wall. Possible resouces are dispersed prehistoric or historic loci on open beach. Nearby, prehistoric burials have been discovered on open beaches in Revere. Resource potential is low due to open setting and road/wall construction.

E. Shirley Point Location is at Shirley Point connection to Deer Island, in roadway. (Shirley Gut between Shirley Point and Deer Island gradually filled in until vehicles could cross over at low tide; the causeway was built in 1940.) Possible resources are prehistoric or historic loci on shoreline. Resource potential is low in the roadway, due to road construction, but moderate if former shoreline is filled over original undisturbed flats.

F. Chelsea Creek   Location is crossing of river from Marginal Street in Chelsea to Condor Street in East Boston, including wharf and filled areas on flats in highly industrialized setting. Possible resources are historic wharves or piers and prehistoric loci on former shore line. Resource potential is low due to historic filling.

G. Orient Heights Beach   Location is transecting filled parking lot and beach to water. Possible resources are prehistoric or historic shoreline loci on filled and natural cove. Resource potential is moderate if beach is filled over original undisturbed flats.

H. Reserved Channel   Location is entry to Channel near granite sea wall. Possible resources are historic walls and wharves. Resource potential is moderate if resources are preserved beneath fill.

I. Pleasure Bay Beach   Location is Pleasure Bay Beach along road and shoreline; beach is artificial fill over shale. Possible resources are prehistoric or historic shore line loci, with small dispersed activity areas likely. Resource potential is low due to road construction and fill.

J. Fort Independence   Location is north side of the park in vicinity of original sea wall, planted grass and trees and MassPort property. Possible resources are historic walls and deposits at shoreline associated with repeated fort habitation. Resource potential is high, if preserved by fill.

References

Bawden, G. 1979. *Phase I Step I Archaeological Survey of the Revere Beach Connector, Revere, MA.* Report on file at MHC.

Bower, B. and M. Roberts. 1985. *Reconnaissance Archaeological Study for 99 State Street Project.* Draft Report on file at Massachusetts Historical Commission.

Kelley, J. 1984. *Skeletal Remains from Chelsea: The U.S. Marine Hospital.* Report on file at MHC.

Luedtke, B. 1976. *Report of an Archaeological Survey of Sales and Green Creek Area: Revere, MA.* Report on file at MHC.

Randall, D. 1981. *Archaeological Survey of the Proposed MDC Sludge Management Plant, Deer Island, Massachusetts.* Report on file at MHC.

Ritchie, D., J. Gallagher and B. Luedtke. 1984. *An Intensive Level Archaeological Survey on Deer and Long Islands, Boston Harbor, Massachusets.* Report on file at MHC.

Ritchie, D. and G. Moran. 1976. *Archaeological Investigations at Fort Independence, Phase I.* Report on File at MHC.

Shaw, L, G. Laden and D. Cushman. 1984. *The Water Street Site: A Study in Prehistoric Adaptation to an Estuarine Environment.* Report on file at MHC.

Stockinger, W. and G. Moran. 1978. *A Final Report of Archaeological Investigations at Fort Independence: 1976-1977.* Report on file at MHC.

APPENDIX E

This appendix presents the methodology used to estimate the suspended solids concentrations in the water column, and the areal distribution of settled sediments, expected from the power-cable trenching operation described in Section 5.3.8, Marine Resources.

In Section E.1, basic information will be presented or derived. In Section E.2, the application of this information towards prediction of suspended solids concentrations will be presented. In Section E.3, the derivation of predicted sedimentation will be presented.

E.1. Basic Information

1. Manufacturer's literature for the jetting device states that one may expect the ejection of 0.02 cu m of suspended sediment per lineal metre of trench.

2. The settling particles of sediment will have a wide range of settling velocities. In this analysis, the range is characterized by the 10th, 30th, 50th, 70th, and 90th percentile values of settling velocity, denoted w_{10}, w_{30}, w_{50}, w_{70}, and w_{90}, respectively. Based on the fact that the silt content of typical bottom sediments is about 50 percent, we estimate:

$w_{10} = 1 \times 10^{-5}$ m/sec $\quad$ $w_{30} = 6 \times 10^{-4}$ m/sec
$w_{50} = 3 \times 10^{-3}$ m/sec $\quad$ $w_{70} = 6 \times 10^{-3}$ m/sec
$w_{90} = 8 \times 10^{-3}$ m/sec

3. The mean water depth is of the order of 4 m.

4. The trenching speed, U_t, reportedly ranges from 5 to 30 m/hour.

5. The candidate trenching routes are as shown in Figure 3.8-1, in Appendix H to Volume 3. Route N-1 runs from Deer Island to East Boston, and Routes S-1 and S-2 run from Deer Island to South Boston. Route S-1 goes all the way into the Reserved Channel to a point west of the Summer Street Bridge, while Route S-2 comes ashore near Fort Independence.

5. Along these routes, the current is assumed to be primarily tidal, and is estimated as follows:

Given the upstream surface area, A_s, where water surface elevation is tidal, and the tide range, TR, the volume of water, V, which flows upstream past the reference point between times of high and low tide is simply the product:

$$V = A_s \times TR \qquad (1)$$

If the cross-sectional area, A_c, of the harbor at the reference point is known, the average velocity of inflowing water is given by,

$$u = V/(A_c \ T/2) \qquad (2)$$

We assume the tidal oscillation to be sinusoidal. Since the ratio of the maximum to the mean of a sin curve is pi/2, the maximum velocity, U is:

$$U = u \ \times \mathrm{pi}/2 \qquad (3)$$

The two proposed cable routes were traced on a map of the harbor and sample points were marked at even intervals on each route (Figure 3.8-1).

The upstream surface area influenced by tides was taken to be the area wetted at mean low tide, plus half of the upstream marshy area; where the marshy area is the area which is wet at mean high tide but dry at mean low tide. A digitizer equipped with a planimeter routine was used to estimate the tidal surface area.

Then, at each sample point, lines were drawn normal to the expected tidal flow, for which cross sectional areas were computed based on soundings data taken from a nautical NOAA chart of Boston Harbor. The outer edge of the marshy area as indicated on the chart was taken to be 5 ft above mean sea level, while the inner edge of the marshy area was assumed to be at mean low tide (4.75 feet below mean sea level).

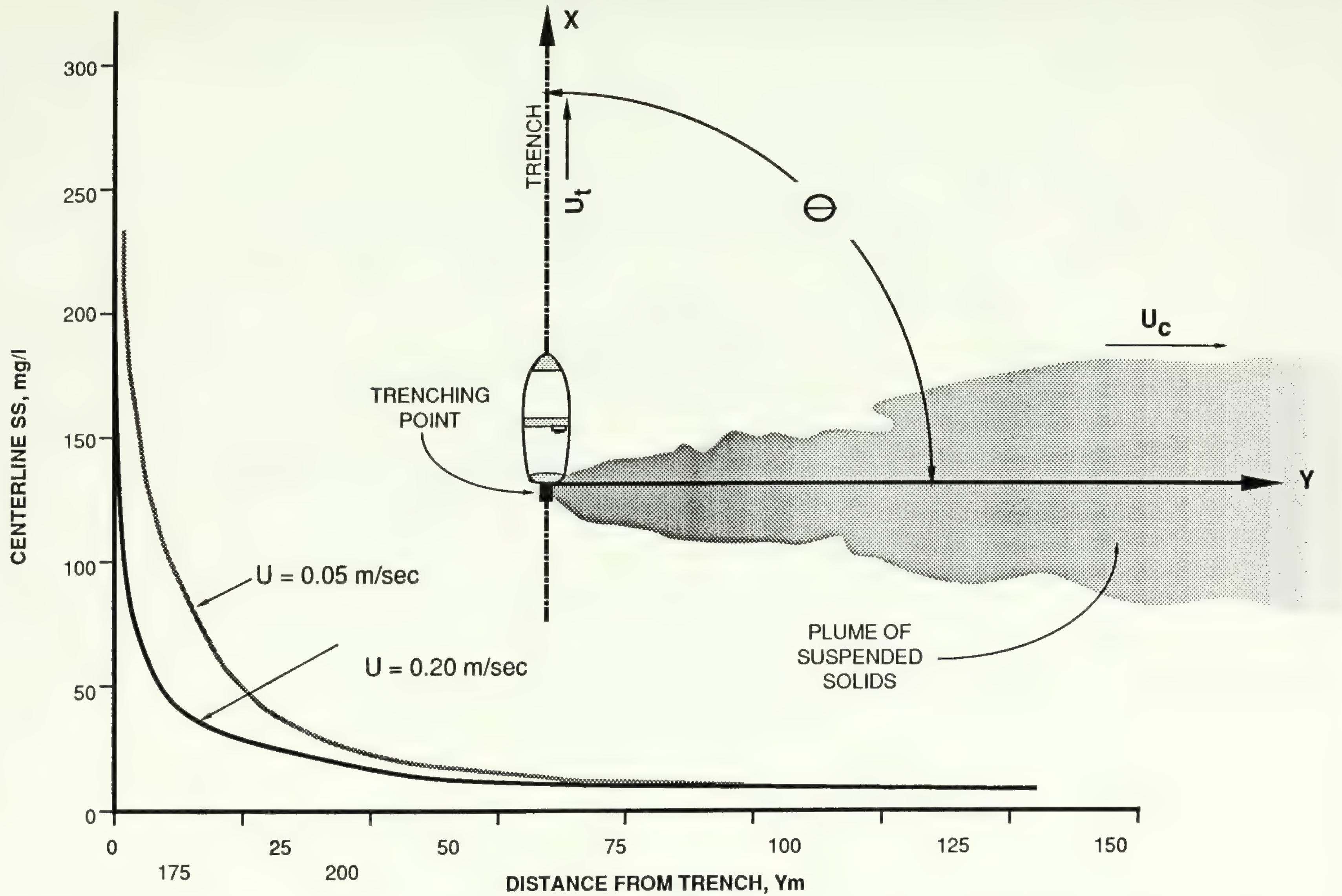
The difference between mean high and mean low tide, 9.5 ft, was used as an estimate of the tidal range.

The direction of lateral velocity may be approximated based on geography of the site and available tide current data. From that estimate of tide current direction, the angle, Θ, between the trench and the current velocity vector was estimated (see sketch accompanying Figure E.1).

Results of the tidal estimation procedure are presented in Table E.1. The value of Θ has been constrained so that $\sin \Theta > 0.5$, to insure at least minimal dispersion of ejected materials even when the flow is nearly parallel to the cable route. We will represent all the perpendicular velocity values by merely three values: 0.05, 0.1 and 0.2 m/sec, which Table 1 shows to bracket the range of values computed for all points along the alignments.

E.2. Prediction of Suspended Solids Concentration

Consider the trenching operation to be proceeding slowly (at speed U_t) along the chosen alignment, while the tidal current moves ambient waters across the alignment (at speed U_c). Consider a coordinate system in which the x - direction is parallel to the trench, and the y - direction is prependicular to the trench (Figure E.1.).



MASSACHUSETTS WATER RESOURCES AUTHORITY

FIGURE E.1
CENTERLINE CONCENTRATION OF SUSPENDED SOLIDS AS A FUNCTION OF DISTANCE FROM THE POINT OF DISTURBANCE IN THE TRENCH

TABLE E.1

Route N-2

section	effective upstream area (sq km)	cross - section area (sq m)	velocity (m/s)	Θ	v sinΘ (m/s)
1	4.18	5887	0.14	180	0.070
2	3.68	5700	0.13	170	0.065
3	3.37	3572	0.19	180	0.095
4	2.40	2461	0.20	180	0.100
5	1.99	2830	0.14	170	0.070
6	1.61	1509	0.22	180	0.110
7	1.49	559	0.54	180	0.270
8	0.82	2371	0.07	180	0.035
9	0.56	2188	0.05	220	0.030
10	0.39	1019	0.08	270	0.080

Route S-2

section	effective upstream area (sq km)	cross - section area (sq m)	velocity (m/s)	Θ	v sinΘ (m/s)
1	4.87	4801	0.21	135	0.150
2	4.58	3585	0.26	105	0.130
3	16.12	22147	0.15	95	0.150
4	14.90	18444	0.16	120	0.080
5	10.02	15632	0.13	200	0.065
6	8.97	10243	0.18	170	0.090
7	8.14	10277	0.16	130	0.120
8	7.72	15335	0.10	90	0.100
9	0.23	2386	0.02	170	0.010

1. We begin with the standard estimate of the volumetric rate of sediment ejection, $Q=0.02\ m^3$ per lineal metre.

2. The trenching speed, U_t, is almost always very small compared to the current speed, U_c, so that at any time but slack water the resuspended sediment plume appears to be streaming out in the y-direction from a quasi-stationary source of strength $QU_t\ m^3/sec$.

3. Convert this to a mass rate, m, assuming that the soil is 65% solids by volume and that the solids have a density of 2.65 tonnes per cu.m.

$$m = 2.65 \times 0.65 \times QU_t = 1.722\ QU_t \text{ tonne/sec} \qquad (4)$$
$$= 1722\ QU_t \text{ kg/sec}$$

4. The plume of suspended material streams out in the y-direction; at any y, the cloud height is H (use H = 4 m always), and the width is 4B, in a horizontal Gaussian distribution in a vertical plane perpendicular to the y-axis, with maximum concentration C and standard deviation B(y):

$$C(x,y) = C_o(y) \exp(-x^2/2B(y)^2) \qquad (5)$$

Integrating the concentration over the vertical plane has to yield m/U_c:

$$m/U_c = H\int_{-\infty}^{\infty} C(x,y)\,dx = \sqrt{2\,pi}\,HC_o(y)B(y) \qquad (6)$$

The standard deviation in the Gaussian distribution, B(y), grows with time. Assume a dispersion coefficient, K, equal to $0.1\ m^2/sec$:

$$K = 0.5\,(d\,B^2/dt) = 0.5\,(d\,B^2/dy)\,U_c = 0.1\ m^2/sec \qquad (7)$$

$$B,m = \sqrt{0.2\ t(sec)} = \sqrt{0.2\ y/U_c} \qquad (8)$$

This gives a cloud width, 4B, of about:

4B = cloud width, m	t, sec after ejection	y,m downcurrent
2	1	U_c
6	10	$10U_c$
14	60 = 1 minute	$60U_c$
44	600=10 minutes	$600U_c$
107	3600= 1 hour	$3600U_c$
152	7200= 2 hours	$7200U_c$
186	10800= 3 hours	$10800U_c$

- Meanwhile, the cloud's maximum concentration, $C_o(y)$, is:

$$C_o = m/\sqrt{2\ pi}\ U_c\ HB(y) \tag{9}$$

- Actually, C_o is reduced further by the settling out of particles. The suspended matter has a particle setting distribution f(w), where w is the fall velocity. Characterize f(w) by the five percentile values w_{10}, w_{30}, w_{50}, w_{70}, and w_{90}, each of which represents 20 percent of the original suspended matter by weight.

- Based on the given silt content (about 50%), the range of particle settling velocities is estimated to be as given in Paragraph 2 of Section E.1.

- For a given w, the rate of change of concentration is:

$$dC/dt = C \exp(-wt/H) \tag{10}$$

Therefore, the settling - diminished maximum concentration is:

$$\begin{aligned} C_m = 0.2C_o\,[&\exp(-w_{10}\ t/H) + \exp(-w_{30}\ t/H) \\ &+ \exp(-w_{50}\ t/H) + \exp(-w_{70}\,t/H) \\ &+ \exp(-w_{90}\,t/H)] \end{aligned} \tag{11}$$

- Values may now be introduced. The range of U_t is said to be 5 to 30 m/hr. The current speed, U_c is zero to about 0.2 m/sec. We may examine two current speeds:

"Slow": U_c = 0.05 m/sec (denser cloud, but moving slowly)
"Fast": U_c = 0.2 m/sec (thinner cloud, but distributing particles farther)

In both cases, consider the greater trenching speed, 30 m/hr = U_t.

$m = QU_t$ = 0.287 kg/sec.
H = 4 m.
4B is given in previous table, a function of t.
$C_o = m/(\sqrt{2\ pi}\ U_c\,HB(y))$.

For U_c = .05 m/sec

t,sec	y,m	C_o, kg/m^3	C_m kg/m^3	C_m, mg/l	X_{10},m	X_{40},m
1	.05	1.14	1.14	1140	2	2
10	.5	.382	.379	379	5	4
60	3	.1636	.155	155	9	6
600	30	.0520	.033	33	17	-
3600	180	.0214	.007	7	-	-
7200	360	.0151	-	-	-	-
10800	540	.0123	-	-	-	-

For U_c = 0.2 m/sec

t,sec	y,m	C_o, kg/m^3	C_m, kg/m^3	C_m, mg/l	X_{10},m	X_{40},m
1	.2	0.286	.286	286	2	1
10	2	0.0954	.0946	95	4	2
60	12	0.0408	.03876	39	6	-
600	120	0.0130	.0085	9	-	-
3600	720	0.0053	.0018	2	-	-
7200	1440	0.0038	.0010	1	-	-
10800	2160	0.0031	.0007	1	-	-

The column headed "X_{10}" in the last two tables is the distance from the plume centerline to the C = 10 mg/l contour. The "X_{40}" column is the same for the 40 mg/l contour.

The centerline concentrations, C_m, are plotted against distance from the trenching point of disturbance, y, in Figure E.1.

E.3. Prediction of Solids Deposition Distribution

E.3.1. Particle Travel Distance

The trenching operation is assumed to throw the dredged particles to a height H m above the level of the harbor bed. (This approach neglects the distribution of heights over which particles will actually be projected.)

Each particle's lateral velocity is governed by the ambient currents, which are assumed to be driven primarily by tides. The current velocity is approximated as:

$$u(t) = U \sin (2 \pi t/T + k) \tag{12}$$

where U is the maximum velocity and T is the tidal period, 12.4 hours and k, the phase angle. The component of the lateral velocity normal to the trench, u'(t) is

$$u'(t) = u(t) \sin(\Theta) \tag{13}$$

Where Θ is the angle between the trench and the current velocity vector.

Each particle is assumed to settle at a constant settling or fall velocity, w, where that velocity is a function of particle size and density. The time over which a particle will settle from the height H to the harbor bed is therefore H/w.

By the time the particle has settled to the bed it has traveled a distance from the trench of

$$X = \int_0^{H/w} u'(t)\, dt = U \sin\Theta \int_0^{H/w} \sin (2 \pi t/T + k)\, dt \tag{14}$$

Evaluating the integral,

$$X = (UT/ 2 \pi) \sin \Theta \left[-\cos (2 \pi t/T + k)\right]_0^{H/w} \tag{15}$$

which leads to

$$X = (UT/2 \pi) \sin\Theta \left[\cos k - \cos (2 \pi H/Tw + k) \right] \tag{16}$$

E.3.2 Estimation of Tidal Current

The values of U sin Θ for each section of routes N-2 and S-2 were tabulated in the right - hand columns of Table 1 in Section E.2.1, above.

E.3.3 Evaluation of Mass Spatial Distribution

A spreadsheet - based particle tracking routine (see Table E.2) was written to determine the distribution of particles with increasing distance from the trench midline. At the top of the spreadsheet the user indicates the following parameter values:

1. current velocity normal to the trench, U_c
2. particle ejection height relative to the sea bed, H
3. the tidal period, T

The header column at the left side of the matrix contains ten values of the tide phase, k. Header rows across the top of the spreadsheet matrix present the assumed particle fall velocity distribution. Five fall velocity values are given: the 10th, 30th, 50th, 70th, and 90th percentile values, just as in Section E.1. For each fall velocity, w, the value H/Tw is computed (third header row).

Although strictly speaking the particles are ejected at only one tide phase per station along the route, the rate of trenching (approximately 30m/hr through sandstone and 5m/hr through granite) is sufficiently slow that the trenching over a representative length may conservatively be thought of as occuring over the duration of a tidal cycle (12.4 hrs). Therefore the distance traveled by representative particles of each settling velocity is computed as if the particles were ejected over each phase of the tidal cycle (0 - 2pi).

In the spreadsheet, Equation (16) is evaluated for each cell of a matrix of tide phase and fall velocities. Values of the tide phase, k, at the time of ejection are row-specific. Values of the fall velocity, w, are column-specific (Table E.2a).

For each cell, computed values of X (Equation (16) are compared with a criterion value, D, assigned by the user in the lower right-hand corner (Table E.2b). If X exceeds D, a "1" appears in the cell; if X is less than or equal to D, a "0" appears in the cell. The fraction of all cells with X less than D is calculated and displayed. Repeated execution of the tracking routine for different D enables estimation of the cumulative distribution of ejected particles per running meter of trench (kg/m) as a fraction of distance, and from that, the actual depth of deposition (mm) at a given distance from the trench midline (Table E.3).

The spreadsheet is used in this manner for a variety of distances D, listed in Column A of Table E.3. For each D, the spreadsheet predicts a fraction, F, of the particles that settle within a distance D either side of the trench, and that fraction is listed in Column B of Table E.3. (Tables E.2 as shown are examples for D = 20 m, fraction settling within D= 20 m of the trench = 0.28).

The remaining columns of Table E.3 are used to compute a distribution of depth of settled sediments, as a function of distance from the trench. In Column C, the length interval, ΔDm, between adjacent D - values is shown. In Column D, the difference between adjacent fraction values, ΔF, is listed. Column E is a tabulation of the ratio ΔF/ΔD.

It is understood that 0.02 cu m per lineal metre is ejected; this equals 0.01 cu m per m for each side of the trench. This is deposited to a depth, d mm, which varies with distance, D, from the trench. The integral of d over distance from the trench must yield $0.01 m^2$, or 10 mm --m, for each side of the trench, if extended from the trench to infinity.

The integral of d from the trench to a distance, Dm, will yield 10 F mm - m. Therefore, the value of d(mm) at any D(m) is 10(ΔF/ΔD) mm.

TABLE E.2(a)
SPREADSHEET FOR PARTICLE TRAVEL DISTANCE

U(m/sec)=	0.05		T=44640sec		
H(m)=	4				
Percentile index	10	30	50	70	90
FallVelocity,m/s	0.00001	0.0006	0.003	0.006	0.008
H/(T*Fall Vel)	8.96057348	0.14934289	0.0298686	0.0149343	0.0112
Tide Phase(radns)					
0.62832	42.407962	285.929332	44.003092	20.828847	15.3942
1.25664	79.4504029	317.391971	64.960967	32.138944	24.029
1.88496	86.1453531	227.621117	61.105849	31.173002	23.4855
2.51328	59.9355576	50.9063392	33.910268	18.299979	13.9712
3.1416	10.8323127	145.253018	6.2379421	1.5630459	0.87954
3.76992	42.4085262	285.930408	44.003459	20.829038	15.3944
4.39824	79.4506762	317.391607	64.961074	32.139009	24.0291
5.02656	86.1452312	227.619451	61.105655	31.172916	23.4854
5.65488	59.935087	50.904009	33.909847	18.299774	13.9711
6.2832	10.8316732	145.255123	6.238429	1.5632905	0.87973

TABLE E.2(b)
SPREADSHEET FOR PARTICLE TRAVEL DISTANCE (CRITERION EXCEEDANCE VERSION)

U(m/sec)=	0.05		T=44640sec		
H(m)=	4				
Percentile index	10	30	50	70	90
FallVelocity,m/s	0.00001	0.0006	0.003	0.006	0.008
H/(T*Fall Vel)	8.96057348	0.14934289	0.0298686	0.0149343	0.0112
Tide Phase(radns)					
0.62832	1	1	1	1	0
1.25664	1	1	1	1	1
1.88496	1	1	1	1	1
2.51328	1	1	1	0	0
3.1416	0	1	0	0	0
3.76992	1	1	1	1	0
4.39824	1	1	1	1	1
5.02656	1	1	1	1	1
5.65488	1	1	1	0	0
6.2832	0	1	0	0	0
				DISTANCE,D:	20
	FRACTION, F, SETTLING WITHIN DISTANCE, D:				0.28

TABLE E.3

COMPUTATION OF DEPOSITION DISTRIBUTION

(A) Distance D,m	(B) Fraction, F	(C) ΔD,m	(D) ΔF	(E) ΔF/ΔD, m^{-1}	(F) Depth of Deposit, d=10(ΔF/ΔD),mm
0	0	1	.04	.040	0.4mm
1	.04	1	.03	.030	0.3mm
2	.07	3	.02	.0067	0.067mm
5	.09	5	.03	.0060	0.06mm
10	.12	10	.16	.016	0.16mm
20	.28	30	.32	.0107	0.107mm
50	.60	50	.24	.0048	0.048mm
100	.84	100	.04	.0004	0.004mm
200	.88	300	.12	.0004	0.004mm
500	1.00				

E.3.4 Results

The calculations in Tables E.2 and E.3 are for the typically slow current speed of $U_c = 0.05$ m/sec. Column F of Table E.3 indicates that the greatest depth of deposit, at the trench ($D = 0$), is $d = 0.4$ mm, decreasing to the order of 0.004 mm at $D = 100$ m.

Use of a faster current speed results in a greater spread of particles, at less depth of deposit.

WATER RESOURCES AUTHORITY
MASSACHUSETTS